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Volume 58, No.8
August 1996

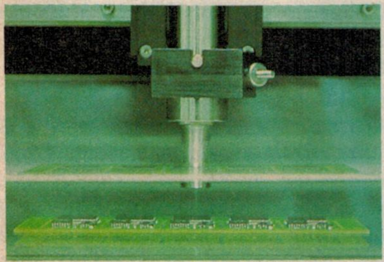
Electronics AUSTRALIA with Professional Electronics & ETI

AUSTRALIA'S LARGEST SELLING ELECTRONICS MAGAZINE — ESTABLISHED IN 1922

Digital TV in the USA

US viewers have been able to receive satellite TV for some years now, but recently three new digital Pay-TV services also became available: DirecTV, USSB and PrimeStar. Tom Moffat reports that the new receivers, with their pizza-sized antenna dishes, are selling like hot cakes. His story begins on page 16.

'Hears' chip defects



US firm Sonoscan Inc has developed a technique of scanning packaged ICs and other components using ultra-high frequency sound, to reveal bonding and packaging defects before they cause trouble. Tom Adams explains, in his article starting on page 26...

On the cover

Graham Cattley's latest project is the 'Pocket Sampler', a low cost digital to analog converter which allows a PC to measure, display and log voltages and low frequency waveforms, and even capture audio samples. It's even powered via the printer port — see his article, starting on page 56. (Photo by Michael Pugh.)

Video and Audio

Features

Projects and Technical

Columns and Comments

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Professional Electronics

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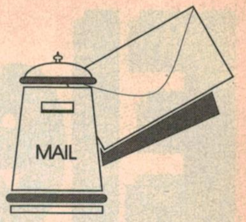
LETTERS TO THE EDITOR



Detector *was* used

I have noted that in his Vintage Radio article in the April issue of *Electronics Australia*, Mr Lankshear makes a comment to the effect that he has no knowledge of commercial use of the high performance detector illustrated in his Fig.6.

Purely as a matter of interest, he may be interested to know that this detector formed the subject matter of an article by F. Langford-Smith in the June 1953 issue of *Radiotronics* (Vol.18 p.79) and was subsequently used commercially in 'custom' wide band high-fidelity tuners. AGC was derived independently using a germanium diode rectifier.

Some hundreds of these tuners were sold in Melbourne by Radio Parts, William Willis and others for use with Quad, Leak and other popular high-fidelity equipment of the time.

L.R. Nayler, LLB, SMIREE
Upwey, Dorset UK

Metal desk unsafe!

I have been reading *EA* and *ETI* since I immigrated to Australia in 1975, and by and large I am very happy to continue to do so. However I feel I must take you to task over a safety issue.

I refer to Peter Lankshear's Vintage Radio column in the May issue. In the photo and text it refers to using a METAL DESK as a workbench for repair of valve radios, etc. Let me point out why this is a DANGEROUS idea:

1. We are talking about equipment which operates at 240 volts or higher, not off a plug pack or battery. It is connected directly to the mains, and generally there is higher than 240V on the secondary side. Of course there are transformerless sets as well, where one side of the chassis is connected to the line.
2. We are talking about radio equipment that had probably failed and was discarded afterwards. What was the fault?
3. We are talking about radio equipment which, even if it was not discarded because of failure, has probably been stored in considerably less than ideal conditions, thus enhancing the deterioration of insulation. Typically in a tin shed, under the house, etc., with very little protection from the elements.
4. Even if you mount the desk legs on insulators (wood is unsuitable as it will absorb water, especially on concrete), other radios, etc., could re-introduce an earth path. Even the test leads from RF generators, etc., could do so.
5. By far the greatest problem is that you aim your article in the sub-heading with '...especially for the newcomer'. You are recommending someone typically with no training, no education, no experience and no supervision, to step into this lethal situation. And when are they likely to do it? Perhaps in their spare time, at night after they are already tired from working a full day, and fatigue is likely to step in...

I hope you will print a BIG retraction in the next available issue. When I did my electronics qualifications in the mid to late 60s we studied valves and transistors. Three rules that will help to keep you alive are:

1. Always work at a non-conductive workbench;
2. Always stand on a non-conductive surface; and
3. Keep one hand in your pocket when testing live equipment.

I hope no one gets hurt as a result of the May column.

David R. Hire,
Annandale, NSW

Comment: We've published your letter in the first available issue, David, because we agree that using a metal desk would be rather risky. However the subheading was referring to people who were newcomers to vintage radio restoration, not necessarily newcomers to electronics and bench work...

Optical Doppler?

I refer to Tom Moffat's article in the May 1996 issue on speed cameras, in particular the reference to measuring the doppler shift on a reflected laser beam. I submit that this is hardly likely.

As the beam is travelling at the speed of light, which is a constant, and any such shift would manifest itself as a change in frequency: towards blue if the target is approaching, and towards red if receding (witness the 'red shift' of light from far-away galaxies). However, it would not be possible to detect this shift unless the vehicle was moving at rela-

tivistic speeds, which you would agree is unlikely...

I humbly suggest that the laser uses carefully-timed pulses, as radar does. In fact, I understand that the system is called 'LIDAR', for obvious reasons.

David I. Horsfall, VK2KFU
Wahroonga, NSW.

Metric or mixture?

As a long term reader of your magazine I would like to take exception to Glenn Pure's letter in the April 96 edition, where he insists you correct all contributed articles to metric measure.

I am of similar age to Tom Moffat. During my education we were taught both metric and imperial measure, because we then were exposed to both in our daily lives. Today's schools only seem to teach the metric system since Australia and New Zealand metricated, even though people still are exposed to both forms of measurement.

Britain has only partially converted, America is still very much imperial and, like it or not, for maybe the next 50 years or more we will have to juggle with both sets of figures as we maintain equipment built under the old systems.

In recent years I have had to teach apprentices the imperial system so they can do their job. A machine built under the old system will never fit comfortably with metric measurements. Three foot between centres, for instance, reads uncomfortably as 914.5mm. A 5/8" Whitworth bolt does not become a 16mm Whitworth one. Horses for courses — we must accept and be prepared to convert and use both standards of measurements in our daily lives.

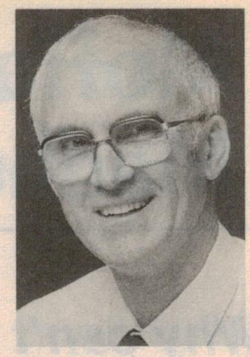
The lighthearted banter used in 'Moffat's Madhouse' is a fair place to use imperial measurements. Tom is reliving his past experiences in much the same way as Neville Williams does in his 'When I Think Back', using the measurements pertaining to the era.

But we *are* trying to advance! The metric system is superior and if we want it to eventually displace the old imperial standard we should insist that all constructional articles are dimensioned to today's standards.

I believe that, to date, you have been careful to work that way. Keep up the good work with your very interesting and informative magazine.

John P. Griffiths
Christchurch, New Zealand. ❖

EDITORIAL VIEWPOINT



Short term savings that could mean disaster in the long term...

In principle, it's hard to criticise our new Federal Government's determination to cut costs and reduce Australia's deficits. However some of the specific areas in which they've either cut costs already, or appear to be preparing to do so in their first Budget seem to me particularly ill chosen.

A few months ago, against the strong recommendations of our top astronomers, the new Government decided not to accept the invitation for Australia to join the European Southern Observatory consortium in building in Chile what will be the world's largest reflecting telescope. This was on the grounds that we couldn't afford the cost, estimated at $30 - 50 million over five years. As a result, Australian astronomers will be unable to participate in this leading-edge project, and are now at risk of falling behind in an area where they've traditionally been leaders. But that's not all — the contracts for the project's high-tech instruments and control systems will now go to European firms, whereas if we had grasped the opportunity many of these contracts were tipped to go to Australian companies (offsetting a significant proportion of the cost of involvement). So our high-tech industry is losing out too.

Now, in the leadup to the Budget, it has been announced that the Government is proposing to either chop, or drastically reduce the allocations for various programs that were established by previous governments to support our high-tech industries. The programs that are likely to be either stopped or emasculated are the R&D tax concessions, the computer bounty scheme, the Tariff Concession Scheme (TCS), the Export Market Development Grant (EMDG) scheme and the Development Import Finance Facility (DIFF).

As various industry organisations and executives have pointed out, cutting these programs is likely to have a disastrous effect on our high-tech manufacturing industries and their export performance. The schemes concerned are estimated to have contributed to a 30% increase in exports over the last five years, and I've seen predictions that their demise could result in a reduction in exports of up to $300 million — as well as possible job losses of up to 4000.

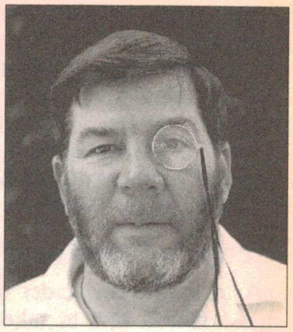
Surely cutting these schemes is a very short sighted way to reduce expenditure. That this approach could even be considered suggests to me either an alarming lack of insight into the roles played by science and technology in the long-term viability of Australia's manufacturing and service industries, or alternatively a conscious decision to 'turn off life support' and simply let these industries wither away...

Either way, I believe there's great cause for concern. If Australia is ever to join the ranks of the first-rank industrial nations, we need a viable high-tech manufacturing industry. Bearing in mind that many of the firms in this industry are already having a tough time surviving (as demonstrated by the fate of Stanilite and Exicom), let alone growing, this is *not* the time for short-term 'save money at all costs' thinking.

Jim Rowe

Moffat's Madhouse...

by TOM MOFFAT



Why can't computers just WORK?

Here's a sad story in the 'backup, backup, backup' category. Lately I've been teaching a radio and TV production course at the high school here in Port Townsend, Washington. Our very first project was to film a forum on drug use in the town, and make it into a short documentary.

Although the kids had undergone just about zero training at this stage, the drug forum sounded like it was going to be a newsworthy event, instead of just an exercise. In other words, the 'real thing': real-world television. This judgment was confirmed the next day when the forum made front-page news in the two local newspapers.

So the class turned up at the forum, organised into two camera crews, complete with semi-pro cameras, professional sound gear, and two sets of television lights. I gave them a half-hour of instant coaching before the event, and then they went for it. The resulting tape they shot was surprisingly expert, and we had the story 'in the can', ready for editing.

Traditional doco

The program was made in the traditional doco style. A reporter's on-camera intro, followed by various speakers interspersed with some voice-over vision of cops working, etc. Since the production was made at the school, we had to use a school computer to write the voice-over scripts, using Microsoft Word instead of my familiar VDE word-processor. It didn't take too long to come to grips with it, and hooked up to an H-P Deskjet printer it produced scripts of fine print quality with nice, big, easy-to-read text.

The last speaker at the forum was a Port Townsend policeman, who talked of the frustration the cops felt watching the kids frazzle their brains on pot or crack, and not being able to do a thing about it. As he finished, this cop broke down and cried, right on camera. This was very heavy, sad, emotional stuff. It was so powerful we decided to make it the finish of the film — dwell on this fellow's anguished face, and then fade to black.

To introduce the cop in the first place, knowing what was coming at the end, we needed to produce a superlative voice-over script. The words had to be just right; the tone and pace had to be just right, to set the mood without sensationalizing it. So I wrote, and edited, and wrote some more. The girl who was to read the voice-over stood near me, and every now and then I'd get her to voice the words direct from the computer screen, to see how it would sound with her reading style.

OK, let's print...

After much agonising over this script, we both agreed we had got it right, so we decided to commit it to paper. I called up the FILE menu, and then hit PRINT, and the computer went into its usual frenzy of clicking and clacking and disk spinning. The printer went ker-chunk a couple of times, and then a message popped up on the screen: 'OUT OF MEMORY. UNABLE TO CONTINUE WITH PRINTING JOB. THIS APPLICATION IS CLOSING DOWN'.

And when it closed down, it took our script with it. Flushed, purged, scrubbed — gone to data heaven. All that work... gone. And, since it was only a short television script, we hadn't bothered to save it. It had gone. Gone.

So the only thing to do was start over. I thought I remembered most of it, so I again started typing madly. But it wasn't the same; the 'just right' quality was gone forever. So we eventually had to make do with an inferior script.

I should have known. That particular computer, and many of its mates, had been out to get me for some time. Crashing, lockups, zapped files — they were all the order of the day. Consider these earlier adventures...

Part of my job has been to collect information from the Internet to aid in the purchase or upgrade of video equipment. This is straightforward enough; sometimes it's just a matter of logging onto some magazine's home page such as **http://www.videomaker.com**, to download copies of articles. Then you just print them out. Simple, huh? Well, no.

In the library

My first attempt was on the very same computer that sent the voice-over script into space. However at that stage it was printing Microsoft Word files all right, but it drew the line at printing under the Netscape web browser. Same message — out of memory — and then, kaboom!

When I growled to the teacher who was the owner of this computer, she said whenever it played up she went to the school library and used one of theirs. So off I went. In the teachers' area of the library were three computers sitting in a row. The first computer ran Netscape all right, but then when it accessed the first World Wide Web page, it just froze up. This was fine as long as you were content to get one page and then stare at it forever...

Computer number two was able to start Netscape, but then it could access nothing further unless you jiggled the network cable coming into the back of it, just so. Computer number three wouldn't work at all. It was totally kaput.

So I abandoned the teachers' workroom and moved out to the main library area, to try computers installed for the use of students. The first one could access the Internet fine, allowing you to view any web page you desired. And when you asked it to print, this computer would go through the motions, accompanied by reassuring messages on the screen: 'spooling page one... printing...' and so on. But when you went into the other room to collect your work from the printer, nothing was there. The print job had simply been sent into the school's local area network, and then to oblivion.

Sharing a table with that computer was another one with an ominous sign taped to it: 'DO NOT ATTEMPT TO USE THIS COMPUTER UNDER ANY CIRCUMSTANCES'. Back in a further room was another computer, sharing a table with the laser printer that served the whole school network. This one, a brand new Power Macintosh, worked like a champ. Good Internet access, fast as the wind, the printer happily whirring away.

So what did we have here? One, two-three-four, five-six, SEVEN computers tried, in order to find ONE that worked properly. Now I considered this situation quite intolerable. When I use my own computer at home, I expect it to work, and it does work. But at the school...? And let's not be coy — six of these computers were Macintoshes, and the seventh, the one that was simply dead, was a PC.

I have a daughter in Sydney who's recently finished university and is now working on an honours project. During an e-mail message to her that evening, I grizzled bitterly about how I'd been stuffed around all day by a whole series of computers that had obviously conspired together to drive me mad. "Oh, don't worry about that", she wrote back, "they are just school computers. All school computers are like that, it's to be expected."

Oh dear. It seems that as part of my daughter's university education, she has been trained to expect most computers to not work properly. 'That's just the way computers are', is the feeling. Well, I've been using computers in my own work since 1982, and I don't expect that kind of funny business. So why are students, and teachers, expected to accept computer problems as a way of life?

That is a very hard question to answer. Sometimes I wonder if it's a matter of over-complexity. The computers in Port Townsend schools can shuffle e-mail all over the place without a hitch. In fact e-mail has proved a most valuable method of communicating with teachers, who are notoriously hard to reach in their classrooms.

Prior to the introduction of e-mail, the best you could do was leave a phone message in the staff room and hope they'd ring you back during a break. Nowadays all teachers seem to make it a point to check their e-mail as the first order of business of the day. And they don't have to phone you back; usually they just type a quick reply.

The trouble seems to come when school computers try the heavy stuff, like running Netscape to access the Internet across the school's own network. Or trying to access a printer across a network. Maybe this is a result of buggy software — one common cure for crashing and locking up seems to be to completely purge a computer's hard disk and then reinstall all the software.

This usually results in satisfactory performance over a time. Over a time — that's the key to it. First the computer works fine, and then it again starts playing up when you try to print under Netscape. And then it starts locking up under Microsoft Word. And then it won't even load Netscape at all, claiming there is not enough memory in the computer, even when Netscape is the only application!

Disappearing memory?

How come there is not enough memory now, when there was plenty of memory two weeks ago? Memory doesn't just disappear, does it? Not to worry, let's just clear out the computer, reinstall the software, and try again — for maybe two crash-free weeks, before the cycle starts all over again. Of course clearing out the computer means zapping the data files as well as the software. So we no longer have ANY copies of the many voice-over scripts written for that drug documentary. Gone west — the whole lot of them.

What I'd like to know is, why is equipment like this allowed to exist in this condition? Many people would say it's due to poor maintenance, and others would say that the computers are breaking down because students are using them. Well, what 'maintenance' could be performed on a computer to prevent it deciding, after a time, that some of its memory was no longer there? And as for students, if it were keyboards breaking, maybe you could legitimately blame the problems on students. But the problem's not keyboards, they keep working fine. All the students are doing is running the software they are told to run, in the way they're supposed to run it. It's not *their* fault.

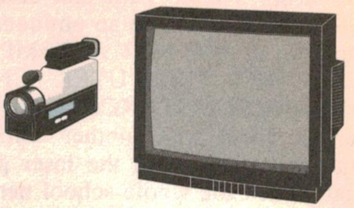
On balance, it's most likely that the computer hardware is all right, or the computers would never work in the first place. That leaves the software, which seems to be coming out of the factory in a condition somewhat below perfection. We all suspect that software is being marketed in a form in which users are expected to do the final debugging. Yet we pay big bucks for the privilege.

Why can't the software companies ensure their products are fault-free before they drop them on an unsuspecting public? I think much of the problem is that modern software is just TOO BIG. Some of it, like Windows 95, runs to millions of lines of code, and it seems to have outgrown the hands of its creators. So the general public is called upon to pitch in with the final development.

There is a ray of sunshine here. The school has one very small lab, consisting of perhaps eight IBM-PC clones, running on their own mini-network along with a printer. The main purpose of this lab is to teach students to use CAD systems, software that will only run on MS-DOS. This of course is the operating system we are being fiercely steered away from by the likes of Microsoft, in favour of Windows.

But the interesting thing is, these eight PCs are student computers too, undergoing the daily torture-test of untrained fingers feeling their way. Yet these computers WORK, they work very well, and they *keep working*. Why? Maybe because they and their software are of a simple design, perfected back in the days before 'software bloat'. Could it be that they knew something back then, that we have forgotten now? ❖

What's New in VIDEO and AUDIO



New system integrates speakers & valve amps

A new high end 'personal sound system' that is claimed to reveal the breathing and hand movements of the recording artist has been launched by Australian audio specialists John Burnett and Dr Simon Marty.

The Lenard Black Opal is a four-way active crossover professional sound system in which the speakers are integrated with ten 100W valve amplifiers. Each of the system's two speaker enclosures has a height of 1700mm and is crafted in solid Australian timber.

Inside each enclosure are two high efficiency 15" bass speakers, which cover the range from 30Hz to 180Hz. The low midrange from 180Hz to 950Hz is handled by a 12" JBL professional speaker with horn loading, while the upper midrange from 950Hz to 7kHz is delivered by a JBL 2446 2" compression driver, again horn loaded. For the range above 7kHz each enclosure uses two ribbon tweeters.

The designers have placed particular emphasis on the upper midrange region, because the ear is most sensitive in this part of the spectrum. The JBL 2446 compression drive has a very high quality titanium diaphragm, with a 4" voice coil. All compression drivers are mounted onto exponential horns that have been machined from solid Australian hardwood, by numerically controlled milling. The density and mass of the horns is carefully selected to ensure that the music is free from unwanted resonance and vibrations.

The matching amplifier system in the Lenard Black Opal consists of ten 100W valve amplifiers in fully balanced configuration. The integrated active crossover system controls power, gain and frequency for each speaker. Two of the 100W amplifiers are used to provide 200W for each bass channel. The output transformers have been designed so that at full power, the frequency response of each channel is flat from 20Hz to 40kHz — without the use of negative feedback.

The amplifiers for each channel are arranged in an elegant 'tower' configuration, with a small footprint.

Dr Simon Marty holds a PhD in Electrical Engineering from Sydney University, and in the 1980s worked as a Research Fellow at the University in the School of Engineering. Fifteen years ago, he first applied engineering technology to the art of classical guitar building. He still builds a small number of classical guitars each year, which are sought after by top professional musicians worldwide.

During the 1960s John Burnett developed and owned Lenard Audio, the premier manufacturer of guitar valve amplifiers and speaker systems in Australia during the 1970s. He is acknowledged as a designer of superior valve equipment and audio systems generally. John has spent much of his time as a teacher of electronics and works constantly to refine and redefine sound systems.

For further information on the Lenard Black Opal system, circle 140 on the reader service card or contact Lenard Audio at 186 Corunna Road, Petersham 2049; phone (02) 569 2702 or fax (02) 569 2002.

New VHS-C camcorder is easier to use

Panasonic has launched a new easy-to-use compact VHS-C camcorder called the NV-RXi. Described as the first model in a new series, the new camcorder incorporates fully automatic operation in AUTO mode, allowing the user to begin shooting immediately.

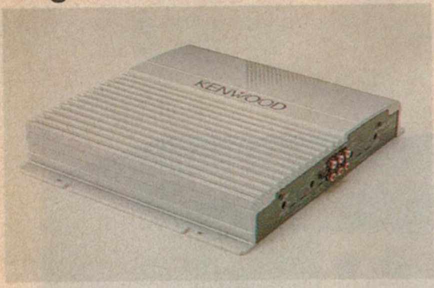
New features include a wide angle lens with 1.4 times the usual field of view which is extremely useful for shooting in limited spaces. It has a 14x optical zoom lens and variable speed power zoom for extra creative control.

The new NV-RXi also has an extreme low light setting of 0.5lux, allowing the user to capture the mood and natural atmosphere even if the light is very low.

For users who want more creativity, there is a manual focus dial below the lens and manual white balance which can be adjusted to create the desired effect. The Program AE (automatic exposure) presets (SPORTS, PORTRAIT and LOW LIGHT mode) allow users to capture optimal pictures in virtually any shooting situation by automatically adjusting the shutter speed and the iris depending on the scene's brightness.

The NV-RXi camcorder is available from leading electrical retailers for a recommended retail price of $1499. For further information circle 141 on the reader service card or contact Panasonic's Customer Care Centre on 132 600.

New car amplifier range from Kenwood



Kenwood has released a new range of KAC car audio amplifiers, claimed to offer outstandingly clean power output and a high level of input/output flexibility for multi-speaker configurations.

Designated the KAC-846 (100W x 4 channels), KAC-746 (70W x 4 channels), and KAC-646 (50W x 4 channels), all three amplifiers boast Kenwood's Tri-Mode operation, allowing them to be configured in three modes of operation: 'standard' 4-channel stereo mode, 'bridged' two-channel stereo mode, or 'tri-mode' — i.e., 2 channel stereo plus single-channel mono. In the KAC-846 for example, you can have two 300W channels or 100W available from each of four channels.

The KAC-846 and KAC-746 feature variable high/low pass filters (50-200Hz, 0.3-1kHz), and the KAC-646 a pre-out high/low pass filter (80Hz). Ideal for multi-way systems, this lets you not only use an amplifier to drive regular speakers or a subwoofer, it also lets you adjust the crossover frequency.

Speaker level inputs — for easy system configuration — feature on the KAC-646, KAC-746 and KAC-846. This lets you boost the output of virtually any cassette receiver or other head unit, even if it does not have pre-out terminals.

The KAC-846 (RRP $549), KAC-746 (RRP $499), and KAC-646 (RRP $399) are all covered by a 12 month warranty and available at selected Kenwood car audio dealers. For further information circle 143 on the reader service card or call Kenwood on (02) 746 1888.

UHF wireless microphone system

Shure's new UHF wireless microphone system offers reliable, professional performance and sound quality for high end installed sound, rental, touring and sound contracting applications. The new system is claimed to offer less interference from RF and television sources than VHF systems and allows users to change frequencies manually, doing away with the need to order factory pre-set frequencies.

The UHF components comprise body-pack transmitters which are compatible with a full range of Shure's lavalier and headset microphones, handheld transmitters with Shure's industry standard mic capsules including the premium Beta 58A and Beta 87, dual and single channel diversity receivers, an active remote antenna kit, an antenna distribution system and cable accessories.

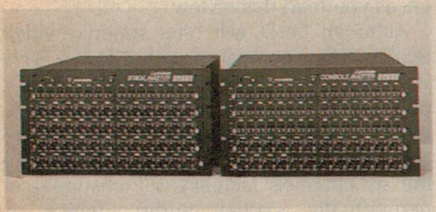
The receivers and transmitters can select between 188 separate frequencies and at least 20 systems can operate simultaneously. Users can set parameters such as group, channel, frequency, squelch, and power and frequency lock functions. Extensive monitoring keeps tabs on performance and battery life, and the receivers and transmitters include user programmable LCD displays for set-up, information and control. A networking port is also provided for future networking facilities.

The transmitters are powered by two AA batteries which typically provide 12 hours of life, and the UHF receiver incorporates an internal switching power supply which enables the system to be operated virtually anywhere in the world.

Pre-packaged systems are priced from a recommended $5195 (single channel) and $8595 (dual channel). System components are also available individually.

For more information circle 144 on the reader service card or contact Jands Electronics, 578 Princes Highway, St Peters 2044; phone (02) 516 3622 or fax (02) 517 1045.

Digital optical 'snake' from Otari



Otari's new Lightwinder Series Optical Cable System is a multi-channel audio cable system which provides an optical digital link between the stage and mixing console in live performance sound reinforcement applications, rendering obsolete conventional discrete analog multi-channel 'snake' cables.

Lightwinder consists of two units: Stage Master and Console Master, interconnected by a single optical fibre cable up to 3000 metres in length. A single system has capacity for 48 microphone or line level stage signals, together with 16 channels of return signals from the console. As signals are transmitted digitally by optical cable, the system is immune from external electromagnetic interference. The system has no CPU, to maximise reliability, and has no power switch to prevent accidental turning off.

Lightwinder may be optionally equipped with a sub-transmission circuit to provide back-up in broadcast applications. If the main circuit becomes inoperative, the system's self-diagnostic function automatically switches transmission from the main circuit to the sub-circuit. Similarly, a dual power supply option is available for even higher operational reliability.

The Stage Master receives up to 48 channels of analog microphone or line level signals, converts the inputs into 20-bit digital audio signal, and sends the signal to the Console Master via its optical transmitter. Each audio input is equipped with a broadcast-quality head amplifier, phantom power supply and mic gain/line trim control.

By having the microphone preamplifiers on stage, the system yields a significant improvement in noise performance compared to analog systems that transmit microphone level signals over great distances.

Both units are fitted with 16-channel Canare multi-pin connectors for analog I/O, permitting rapid connection to Canare stage boxes and fantails. LEDs provide instantaneous indication of signal presence, warning and clipping, while a 12-segment LED meter and headphone output are available for signal transmission checks. Both units are housed in 6U rack mounting enclosures.

For further information circle 145 on the reader service card or contact Amber Technology, Unit B, 5 Skyline Place, Frenchs Forest 2086; phone (02) 9975 1211 or fax (02) 9975-1368. ❖

KENWOOD'S KR-V990D A-V SURROUND RECEIVER

This month our reviewer Louis Challis had the opportunity to test another surround sound receiver incorporating the new AC-3 — renamed Dolby Digital — 5.1-channel digital surround sound system. Kenwood provided its new KR-V990D A-V Surround Receiver complete with their LVD-Z1 Laserdisc player, LS-707M main stereo speaker system, LS-C100 centre speaker, CM-5ES surround speaker system and SW-300 powered subwoofer...

At the end of 1994, there were approximately four million home theatre systems in the US. By the end of 1995 the Consumer Electronic Manufacturers Association (CEMA) presented revised estimates, and claimed that that number had jumped to 10 million home theatre systems. For a figure of four million to expand up to a figure of 10 million in one year, is an absolutely astounding numerical jump. The number of systems is less impressive than their commercial value, which would be approximately US$7 billion — hardly a small sum of money.

All right, I acknowledge that there is a significant time lag between US trends and their subsequent emulation in Australia. But irrespective of how you rationalise the unprecedented growth in the US home theatre market, we can reasonably expect that sometime in the next 2-3 years, Australia will follow suit.

Whilst the focus of the American market place was laserdiscs, which generally outperform the VHS video cassettes in every department, our (Australian and New Zealand) markets have virtually ignored laserdiscs, perhaps because our PAL system is already superior to the NTSC video cassette system.

Whilst I acknowledge there are a small number of video shops which rent (NTSC) laserdiscs, they are generally few and far between. The average Australian has never experienced the full audible and visual potential of the latest generation of laserdiscs, which now provide the opportunity to replicate cinema, visual and audible dynamics in your own home.

Whilst the visual characteristics of those laserdiscs are good, the audible characteristics range from truly outstanding to mind-boggling performances.

The major Japanese, American and European manufacturers of high fidelity equipment have accepted that as good as they are, laserdiscs aren't good enough, and that a superior system has been long overdue. That system is close at hand in the form of Digital Video Discs (DVD), with the first of the DVD players becoming available in the US as you read this review.

Although DVD will offer superior video quality when compared with either a VHS video cassette, or even a laserdisc, that is only half the story. The most important technical advance incorporated in the future generation of DVD discs and software, are the six channels (actually 5.1 channels) of perceptually coded audio, which is squeezed into a data stream running at 384 kbytes/second — about 1/4 of the data rate of an ordinary 2 channel CD.

Modelled on the way that the human ear works, the perceptual coders shrink the data stream by discarding sounds that are either too soft to hear, or have been masked by louder sounds. Now, although Dolby and I have previously described that system as AC-3, Dolby have decided to rename the AC-3 system to 'Dolby Digital'.

The Dolby Digital system has 5.1 channels of audio, offering an 85dB dynamic range — approximately 10dB better than the Dolby Pro Logic system which it effectively

replaces. More importantly, it achieves enhanced audible realism, as there will be now full separation between all 5.1 channels, which is something Dolby Pro Logic could never achieve.

For the first time there will be a distinct and separate centre channel, to cater for dialogue intensive movies where noise immunity is an issue. Even the best Pro Logic components suffered from potential noise intrusion problems, with an automatic outcome resulting from the matrix format incorporated in the Dolby Pro Logic system.

Whilst the Dolby Pro Logic system had an effective bandwidth of 100Hz to 7kHz for the mono-surround channel, the Dolby Digital system provides two discrete and completely separate surround channels, which provide genuine 20Hz to 20kHz bandwidth.

With that sort of data at the producer's fingertips, the sound engineers have the flexible and powerful tools to create spatial and ambient effects which rival (or even outperform), a 'real-world' situation.

When I heard my first Dolby Digital AC-3 sound system last year, reproducing a AC-3 encoded laserdisc, I said "WOW — this is the way of the future". Once having heard a system with that potential, few users would be willing to go back to their Dolby Pro Logic or conventional stereo sound systems when listening to pre-recorded video software.

So what happens to the 10 million plus existing home theatre systems in the USA? Well, most households will soon take the plunge, and will purchase at least one extra component, which will probably be a new DVD player. Based on the information being disseminated by Toshiba, that player will cost somewhere between US$500 and $1000, to provide that instantaneous upgrade.

Others who have spent considerable sums of money on their existing systems will add a Dolby Digital converter, and will integrate that into their existing system. In Australia, where there are currently relatively few home theatre systems, the task will be more straightforward, even if it ends up being more expensive.

Kenwood's KR-V990D

Kenwood Electronics Australia has released its KR-V990D audio/video surround receiver incorporating the new Dolby Digital Decoder, and also a Dolby Pro Logic surround decoder for good measure. The major features of this system are three x 100 watt amplifiers for the right front main channels and the centre channel, and the two x 70 watt surround channels — covering five out of the 5.1 channels of the Dolby Digital system.

To provide that sixth '0.1' subwoofer channel, you will need a separate self-powered subwoofer.

The system also provides DSP logic for a limited range of special effects, based on digital signal processing for the Dolby Pro Logic — but of questionable benefit when dealing with appropriately encoded Dolby Digital software. Other features provided include two Macro functions, which facilitate performing a series of pre-programmed operations at the touch of a button.

The incorporation of a graphical user interface (GUI) with on-screen display capability simplifies the adjustment of multiple variations in functional controls which are an integral component of the system's software. All of these functions require the use of the remote control.

The new remote control is 'user friendly' and capable of being adapted to control almost any other brand of equipment integrated into your system. The only proviso is that the subject item of equipment already incorporates a remote control function.

The primary RF input and a separate digital (coaxial) input are provided for the Dolby Digital system. RCA output jacks provide access to the preamplifier output stages of all six channels. The simplified GUI controls, with supplementary memory, facilitates the pre-adjustment of the sensitivity of each channel's input. You can then ensure that the operational and functional output level differences between various items of equipment will conform to a pre-determined overall balanced electro-acoustical sensitivity.

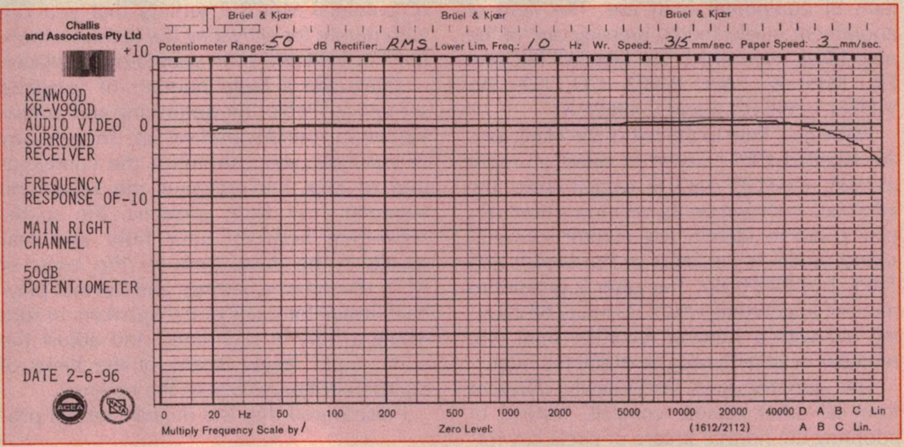
As with the Yamaha DSP-A3090 system which I reviewed last month, the Kenwood KR-V990D provides the intending user with a range of functions and controls which must ultimately exceed the known needs and future requirements of all but the most demanding of users.

The inbuilt digital audio section accepts digital signals with sampling frequencies of 32kHz, 44.1kHz and 48kHz. The receiver's video section is designed for NTSC video format, and accepts video inputs and outputs in the form of composite video, as well as S-video, which is now the preferred VCR format in both Japan and the USA.

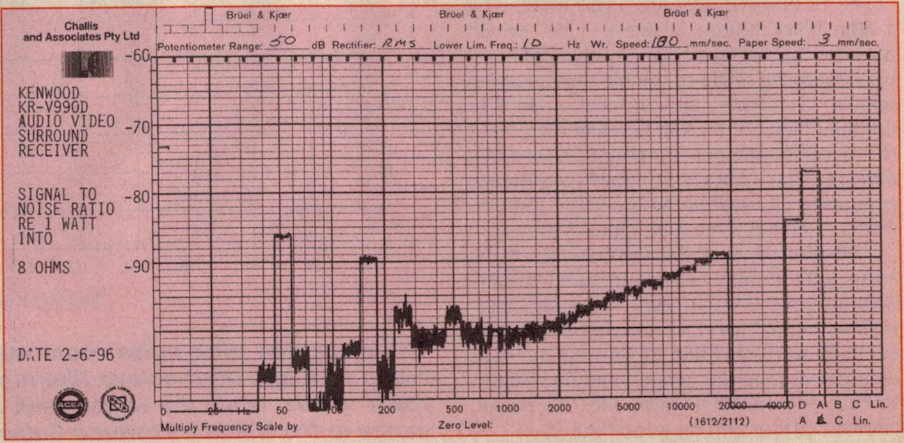
Built in tuners

If you thought that the receiver was limited to reception of video content (laserdiscs, DVD and VCRs), you would have been wrong! This receiver also incorporates a potent tuner section, with a quality FM tuner which provides an excellent 1.2uV sensitivity, and genuine broadband 18kHz effective bandwidth. It also incorporates a reasonable AM tuner, which is configured to accept either the 9kHz or 10kHz steps of the various countries in which it could be used.

Whilst the KR-V990D front panel provides a limited number of switches, buttons and controls, after assembling the receiver into a functional system (by connecting up loudspeakers and associated items of equipment like the laserdisc player), the preferred method of control is by means of the 'RC-



Two plots of the measured performance of the Kenwood KR-990D A-V Surround Receiver. At top is the frequency response of the main right channel, with -3dB points at about 6Hz and 91kHz.
The lower curve shows the signal to noise ratio relative to 1W into 8 ohms — particularly good, at 84.5dB(A)



R0903' remote control.

The ergonomic design of this unit follows a different, and I believe a more sensible tack than most other remote controls which I have assessed, or which you will find in the shops. The first and most important difference is that the primary control buttons are a soft grey colour to attract your attention, with the secondary control buttons being black (and generally smaller in size).

There are five (5) grey keys at the upper (outer) end of the remote control. These are arranged to cover the four directional quadrants, with the fifth central key providing additional functions. By depressing one or two adjacent keys simultaneously, you achieve an eight-sector directional control — simply, conveniently and most ergonomically.

As the handbook revealed, these five keys have a dedicated set of functions when the receiver, tape recorder or mini disc player, CD player, laserdisc player or tape recorder II or second mini-disc player, are selected and in use. Those controls include standard functions of PAUSE, PLAY, FAST FORWARD, REWIND, SKIP, STOP, RECORD, SEARCH and channel TUNING, depending on which item of equipment is in use. The item of equipment is selected by pressing one of the nine black keys which are labelled RECEIVER, TAPE A, TAPE B/MD, CD, LD, TV, VIDEO 1, VIDEO 2 and CABLE/SAT.

Three grey keys to the left of the black keys are labelled INPUT (used to select an input source); DISPLAY MODE (which alters the information shown on the receiver's front display panel to identify the current surround sound mode — i.e., AC3 or Pro Logic); and TAPE 2 (MONITOR). The latter is pressed to monitor a recording which you may be carrying out with a cassette recorder, mini disc recorder or other analog or digital recorder.

The numeric keys are visually different from all other remote controls. Instead of adopting the normal square or circle key format with the number engraved or painted on the front, each key has the bold outline shape of the number. Whilst you may think this has a hint of 'kitsch', I believe there is real merit in having a key that you can correctly identify in almost any light.

The 10 numeric keys are supplemented by a little black button labelled '+10', which provides the means to dial any channel number containing single or double digits. Having selected a number, all you have to do is to use the black ENTER key to select a TV, VCR or US cable channel. (At this point of time, Kenwood have not yet provided us with programming information to meet the requirements of Foxtel, Galaxy or Optus Vision.)

Two grey keys at the lower edge of the array of the remote control are labelled ANY with an up and down sign. These keys provide tuning UP and DOWN with the receiver, PLAY and REVERSE PLAY with the tape recorder or mini disc player, and FAST FORWARD and REWIND with the CD player, laserdisc player and tape recorder B.

The remote control has a pair of grey control buttons for adjusting the audible volume UP or DOWN, and a red button labelled REC (record) for use with tape recorders A and B.

Two remaining switches labelled MACRO 1 and MACRO 2 facilitate the use of a simple set-up code chart, which allows you to look up the VCR set-up codes for a multitude of VCRs, TV sets, cable receivers, laserdisc players and US satellite systems. Having identified the set-up codes on pages 34 to 38 inclusive of the instruction manual, the procedure then involves keying in the one, or multiple sets of numbers in turn. When one of those sets of numbers activates the power for the particular component you wish to use, you can identify the correct set of numbers. By selecting video 1 or video 2 input on your TV set (or video monitor screen), and after entering the correct set-up code again, you can select the SET position on the monitor screen to enter the information.

The MACRO set up facilitates controlling several components in succession, so that a series of operations will be automatically activated simply by pressing the Macro 1 or Macro 2 key. There are an extensive range of potential MACRO settings that you can incorporate for activating the receiver, monitor TV, VCR and even your laserdisc player.

There are a large number of surround set-ups available, for optimising and adjusting the surround sound set-up. Thus by way of example, you can adjust the configuration to take into account the separation between your front speakers, the spatial separation between your front and rear speakers, the delay time for Pro Logic or AC3, the volume settings and normal playback levels for each of the speakers in turn (using a built-in test tone), and adjust the audio input levels of any of the items of equipment connected to the receiver.

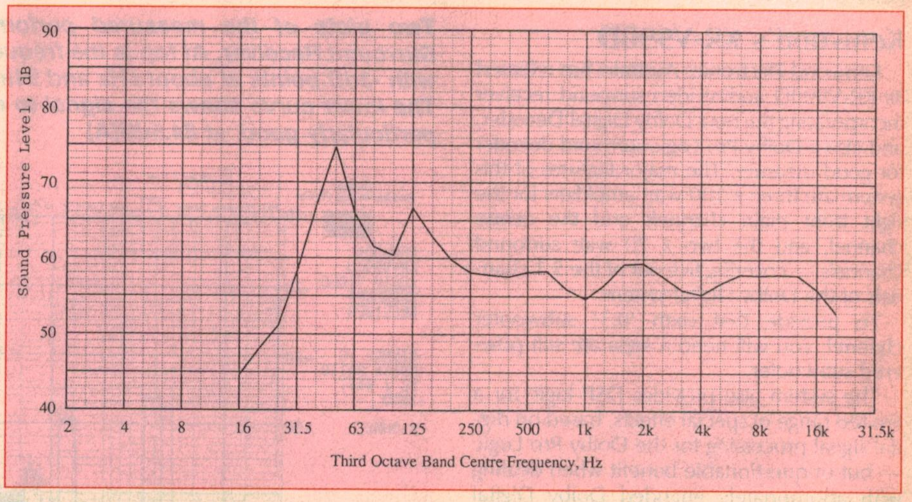
I discovered that the default settings provided by the system were by no means the most appropriate, and some experimentation is required to optimise the system's performance to cater for the peculiarities of the room in which the system is installed. (This proved to be an equally significant problem with the Yamaha DSP-A3090 system, which provides a wider and far more comprehensive range of broad band and discrete spectral sound field adjustments.)

The range of optional ambience effects provided with the Kenwood KR-V990D are nonetheless impressive. When you accept the premise that the primary purpose for purchasing this piece of equipment would be to provide a superior home theatre system, you then realise that this system does in fact provide appropriate flexibility to cater for almost any situation — provided the speakers are of good quality. By contrast, the Yamaha system provides a wider range of controls, which facilitates making appropriate corrections for some less-than-adequate loudspeakers...

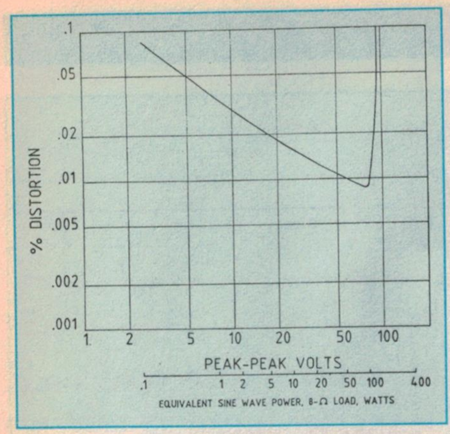
An examination of the face of the receiver, reveals that it is neatly designed, with most of the expected functional controls, but with lettering and engraving which is a trifle small for people with poor vision.

The rear of the receiver presents an impressive array of multi-coloured sockets for AM/FM antennas, digital RF and TV cable or Dolby Digital input, seven S-video sockets and seven video coaxial sockets with six related pairs of audio sockets. There are also six pairs of audio sockets for interconnecting related audio equipment, and seven pairs of colour coded terminals for connecting front, centre, rear and surround speakers.

The terminals used provide for bare wire connection, or for thin speaker plugs (which are thinner than ordinary banana plugs). The speaker terminals provided appear to be the same format as those used by Yamaha on its DSP-A3090 receiver. Although those termi-



The measured pink noise room response for the Kenwood system, measured with one-third-octave filtering. The smaller peak at 125Hz is due to a room mode, while the larger peak at 50Hz turned out to be due to a resonance in the SW-300 Powered Subwoofer.



The distortion of the Kenwood KV-990D right channel, measured using the IEC HF total difference frequency method. Below 75W, it's excellent.

nals fulfil their role, I would still prefer conventional universal sockets which will also accept conventional banana plugs.

The additional RCA sockets are provided for pre-amplifier outputs for each of the five main channels, together with a sixth socket for a separate self-powered subwoofer.

One unusual facility provided, which I have only infrequently seen before, is a shrouded two-pin mains socket which provides power for a supplementary switched item of equipment.

The rear of the amplifier module incorporates a thermally activated, small but efficient and moderately quiet axial cooling fan. The fan only comes into action when the temperature starts to build up on the heatsinks, with average power outputs of the order of 10 watts or more. With power outputs of that order you are unlikely to hear the fan. As the power level drops, the fan rapidly switches off, and so you are unlikely to be disturbed by its operation.

An examination of the inside of the unit revealed that it is neatly constructed, with reasonable quality components on clearly labelled printed circuit boards. A main motherboard is supplemented by ribbon cabling interconnecting the multiple boards and multiple sockets.

Objective testing

The objective testing revealed that each of the amplifier channels easily achieves the manufacturer's published ratings, with smooth responses, which have a typical lower limiting cutoff frequency of 6Hz and upper cutoff frequencies of 91-95kHz. The three main amplifier channels reached the on-set of clipping at 105 watts output, and the distortion levels are quite acceptable to just below that output.

The supplementary surround channels (4 and 5) provide a genuine 70W output, but once you get past 73W you're into the clipping zone.

The IEC total difference frequency distortion measurements are excellent below 75W output on the main channels, and remain generally below .02% until the power output drops to relatively low levels. The signal to noise performance of the amplifier is particularly good, being -84.5dB(A) relative to 1W into 8Ω.

Overall, I simply couldn't fault any of the amplifier's performances, which were broadband, 'gutsy' and most effective.

I briefly evaluated the performance of the FM tuner, which has a 1.5uV sensitivity, and an extremely smooth frequency response from 20Hz to 16kHz. The AM tuner regrettably provides a similar performance to most other AM tuners, with a nominal 3.5kHz bandwidth — which is good for the news, talkback shows, and some music.

Subjective testing

Kenwood provided a Kenwood NTSC laserdisc player to assist us in our evaluation. Although I initially thought the laserdisc player was manufactured by another firm, with just 'badge engineering', I was wrong. Kenwood make their own laserdisc player, and it turns out to be very impressive and functional. Its best feature is that when you terminate the playback of a laserdisc in the middle of the program without unloading the disc, and turn off the power, the player remembers the precise point in the program where you terminated your playing. When you turn the player on again, one minute or one day later, the player re-cues the laserdisc to the appropriate spot, ready to continue playing without fuss or bother.

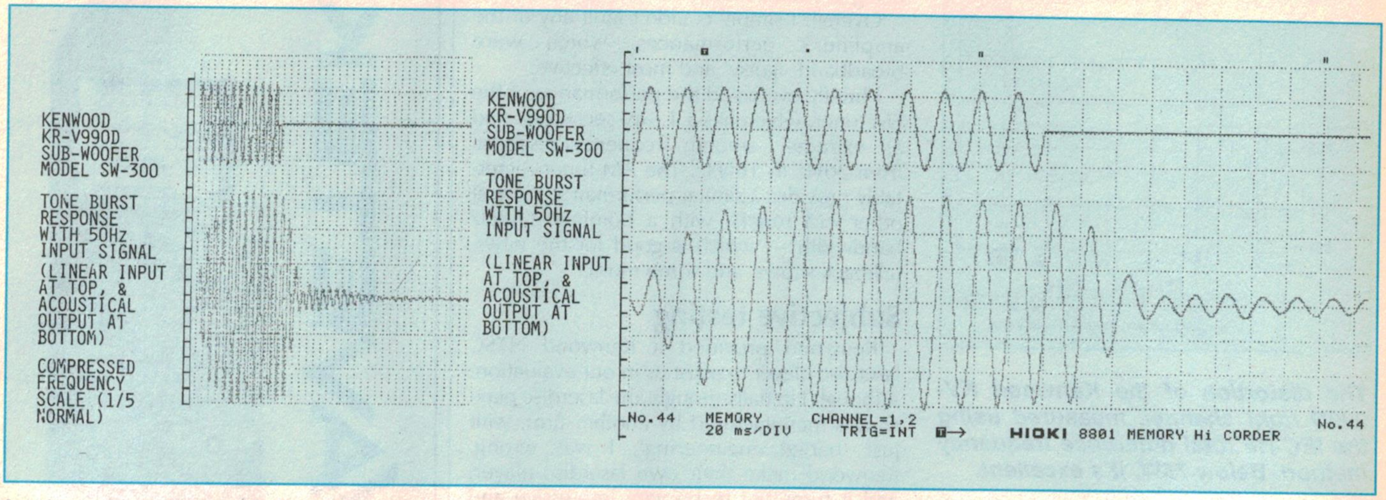
Kenwood in fact provided a complete home video system consisting of a Dolby Digital compatible (AC3) laserdisc player, the KR-V990D audio video surround receiver, two main frontal and one centre loudspeaker, two rear channel loudspeakers, and a subwoofer incorporating its own amplifier. All I had to provide was an NTSC compatible TV set with which to view the video component.

Setting up the Kenwood system was relatively straightforward, even though it was time consuming — particularly if you have never done it before. On this occasion, following last month's experience, I decided to let Peter Endrey, Kenwood's National Sales/Marketing Manager for the Home and Hi-Fi Audio Division, set up the system...

In hindsight I made the right decision, as it took Peter about three hours to set it up correctly. Once set up however, the results were truly impressive.

Before embarking on a serious viewing and listening exercise, we took the trouble to measure a number of key parameters. Those included the peak undistorted output of the system, and the frequency linearity of the system with a pink noise source to measure the 1/3 octave band room response. For interest's sake I also decided to assess the frequency response of the subwoofer.

The peak output of the system at a central listening position exceeds 110dB(C), which is not to be sneered at. Sound outputs of that order could pose some potential dangers, if maintained for any length of time. What surprised me was how easily you could achieve those sort of levels without realising the absolute sound levels which you were creating, because of the low distortion levels at which the system operates.



Intrigued by the peak in the overall room response at 50Hz, Louis Challis checked the SW-300 Subwoofer using tone bursts. As you can see from these compressed and uncompressed plots, the response confirms that the subwoofer has a pronounced resonance.

The pink noise 1/3-octave band room response proved to be reasonably smooth, apart from a prominent peak in the vicinity of 50Hz and a smaller peak at 125Hz due to a dominant room mode. Otherwise it was better than +/-6dB from 30Hz to above 16kHz.

That obvious peak at 50Hz had me intrigued, so I decided to firstly measure the response of the subwoofer, which proved to be the culprit. I then decided to take that assessment one step further, and to measure the transient response of the subwoofer when excited by sine-wave tone bursts at 50Hz. As you will note from the attached results, the subwoofer is resonant at 50Hz, with significant delay in responding to the leading edge of the tone burst, and an even longer audible decay time at the end of each tone burst.

After completing my objective assessment, I sat down in a comfortable position with a friend and monitored the audible quality of the system whilst viewing appropriate software.

The subjective evaluation initially focused on a series of recent laserdisc releases incorporating Dolby Digital (AC-3) sound tracks. From the opening sequence of the first laserdisc that I played, I was impressed by what the composite system achieved. Unlike the Yamaha system where I used an array of existing high and low quality loudspeakers to provide five, but not six channels of sound, the Kenwood system had the advantage of all six (actually 5.1) channels of audio reproduction.

That sixth or '0.1' channel, covering 20Hz to 110Hz, is more important than you might imagine. It provides the audible 'thump' that you need to reproduce the explosions, crashes and impacts of fists on faces, which tend to be a common occurrence in some video software.

The first video that I selected for my evaluation was Bruce Willis in *Die Hard With A Vengeance*. I had previously viewed that particular laserdisc video in a demonstration suite earlier this year, at the Las Vegas Consumer Electronics Show.

For those of you who are unfamiliar with that particular video, it starts with a series of explosions, which sound every bit as good in the setup that I had, as it did in the professionally adjusted and carefully aligned monitoring suite in Las Vegas.

Whilst I acknowledge that this movie is not the type of software which I hanker to watch, it nonetheless satisfies a remarkable proportion of the viewing market in both this and other countries. The audio performance of the system for that particular video achieved a score of '10 out of 10' for audible fidelity and credibility. The explosions and bangs were awesome in their reality, and that subwoofer provided a truly outstanding performance.

Whilst I briefly watched excerpts from some of the other laserdiscs, all that did was to convince me that once having listened to a fully fledged Dolby Digital system replete with all six channels of sound, you would experience considerable disappointment if you had to return to a conventional stereo replay system — or worse, a single channel audio system.

With a comprehensive sound system offering the exciting audio potential that this system had to offer, I decided that I really had to evaluate its performance with some CDs. The two CDs that I selected for my evaluation were interesting, and divergent in their content. The first was new rendition of an old opera, Antonio Carlos Gomes' 'Il Guarany', with Placido Domingo in one of the lead roles. The music was good, the disc (Sony Classical S2K 66273) was excellent, and the reproduction was outstanding. So far so good...

I progressed to a slightly different disc genre, 'Winds of War and Peace' with Lowell Graham conducting the National Symphonic Winds, (Wilson Audiophile WCD-8823). This is bold and brilliant brass at its best, and was recorded with sufficient care and dedication to justify 500 gold plated CDs. The Kenwood system produced an unbelievably realistic sound reproduction, and I felt I was sitting amongst the orchestra, or at worst sitting in the front row right in front of the musicians.

Summary

The Kenwood KR-V990D Audio Video Surround Receiver is a well conceived piece of equipment. Although it is good and provides excellent amplification and control functions, in the end the quality of sound it produces can be no better than the quality of loudspeakers with which it is interfaced. Even with good speakers, you must have appropriate guidance or installation of the system by people with appropriate expertise to set it up.

Dolby Digital sound is unquestionably the 'new frontier'. By next year, following the release of DVD in the USA, that frontier will look and sound even better. Of course, high quality CDs are currently good, with some outstanding discs amongst the many.

If you are prepared to spend something like $2000 plus on a surround receiver, then I believe you have to be prepared to spend in excess of $3000, and preferably $4000 on top for your loudspeaker system. Without that expenditure you will never quite achieve the standard of reproduction which is justified by the medium. However, when you finally commission your Dolby Digital Audio Video Surround System, then the results should be worth all the time, trouble and expense.

By the time you reach that stage, you should be able to equal, or outperform your local cinema. At that stage, your listening pleasure will experience a quantum leap compared with what you have experienced for the last 10 years with hired or pre-recorded videos.

The Kenwood KR-V990D AV Surround Sound Receiver measures 440 x 396 x 162mm (W x D x H) and weighs 13.2kg. The quoted RRP is $2299. Further information is available from Kenwood dealers or from Kenwood Electronics Australia, at Australia Centre, 8 Figtree Drive, Homebush 2140; phone (02) 746 1888. ❖

SHORTWAVE LISTENING

with Arthur Cushen, MBE

India's new Broadcasting House

A massive undertaking is proposed by All India Radio in Delhi for updating their External Service, and the building is now under construction. It is housed at the back of the present All India Radio studios on Parliament Street, and is expected to be completed by the year 2000.

The new broadcasting house will have 27 transmission studios and connected facilities spread over five floors of the studio block. There will also be a seven storeyed office block for the External Services, News Services and Home Services of All India Radio.

The new complex will have most modern facilities, including centralised digital recording and playback systems and an electronic news room system for fast processing and broadcast of news. Emphasis will also be laid on creating requisite facilities for interactive programming, enabling listeners to actively participate in AIR programmes.

Building design of the new broadcasting house draws inspiration from the predominant environment of the Parliament House building, according to *India Calling*. On its completion, the entire transmission activity will be shifted to this complex and the existing broadcasting house will be used as an exclusive recording and production centre, using the latest digital technology.

AIR broadcasts its External Services in 16 foreign and six Indian languages to 84 countries around the world for a duration of over 69 hours each day. The Home Services, which started with 18 transmitters and covered 11% of the population, now covers 96% of the population with 290 transmitters. Shortly the coverage will be almost total.

All India Radio broadcasts in English to Australia and New Zealand at 1000-1100UTC on 13,700kHz, 15,050 and 17,387kHz, and 2045-2230 on 7410kHz, 9950 and 11,620kHz. The address of All India Radio is PO Box 500, New Delhi 110 001, India.

VOA Sao Tome

The Voice of America has put into operation a new relay base on Sao Tome, consisting of one 600kW mediumwave and four 500kW shortwave transmitters. This base has been built to replace the one in Monrovia, Liberia which was destroyed in the fighting in 1990. Since then VOA has operated a small station in Botswana and used facilities in South Africa.

Sao Tome is an interesting new country for shortwave listeners. It is an island group which consists of two main islands and several smaller ones in the Gulf of Guinea, off the coast of West Africa and close to Gabon and Cameroon. The island was a Portugese possession until 1973, when it achieved internal self government. In 1975 it achieved independence.

The broadcasts of the VOA from this site are in English, French, Portugese and other African languages. The present schedule for English broadcasts is: 0300-0500 on 6080kHz; 0630-0700 Saturday and Sunday on 6080kHz; 1600-1630 Saturday and Sunday on 6035kHz; 1630-2200 daily on 6035kHz; and 2200-2230 Monday to Friday on 6035kHz. A late change is that the broadcast in French, Portugese and Hausa has been changed from 9585kHz, and is now 1600-1730 on 9815kHz and 1730-2030UTC on 9780kHz.

US radio sessions

Two sessions for the shortwave listener which are well received in the South Pacific area are Glenn Hauser's 'World of Radio' broadcast on WWCR, Nashville, Tennessee and Marie Lamb's 'Cumbre DX' heard on WHRI, Southbend, Indiana and KWHR, Hawaii.

World of Radio is broadcast Thursdays at 2030UTC on 15,685kHz; Fridays 2115 on 15,685kHz; Saturdays 1030 on 5065kHz; Sundays 0700 on 3315kHz, 1800 on 12,160kHz and 2130 on 9475kHz. The Cumbre DX programme is heard on KWHR Saturdays 0200 on 17,510kHz, 0500 on 17,780kHz and 1430 on 9930kHz; Sundays 0200 on 17,510kHz and 1830 on 13,625kHz; Monday at 0330UTC on 17,510kHz. ❖

AROUND THE WORLD

FRANCE: The latest Radio France International (Paris) schedule to Oceania in English is 1200-1300 on 11,600kHz and 1400-1500 on 7110kHz and 15405kHz.

KOREA: KBS, Seoul, opens at 1830UTC in English on 3955kHz. This is a BBC Skelton transmitter for reception in Europe.

MOLDOVA: Radio Moldova International, Chisinau heard opening at 0430 with an anthem on 7520kHz followed by news and comment on Moldova life. At 0450 there is a request for reception reports including mail, phone and fax numbers, then sports news. The station closes at 0455 with the schedule and the frequency is often jammed.

POLAND: Warsaw broadcasts in English at 1200-1255 on 6095kHz, 7145, 7270, 9525 and 11,815kHz; 1700-1755 on 6095kHz, 7270, 7285kHz; and 1930-2025 on 6035kHz, 6095 and 7285kHz.

QATAR: Doha broadcasts in Arabic 0245-0700 on 9585kHz; 0800-1600 on 17,830kHz; and 1700-2130 on 11,740kHz. All transmitters are of 500kW.

SOUTH AFRICA: Channel Africa, Johannesburg is heard opening at 0500UTC on 9590kHz with news, followed by international news and at 0515 on Saturday has a Mailbox. The station is offering a new magazine, *Hello Africa* to listeners.

ST HELENA: In recent years broadcasts from St Helena have been carried on a bi-annual basis and this has given listeners worldwide a chance to hear this interesting station. This year the transmission is scheduled for Sunday October 27 from 1900UTC on 11,092kHz. The transmitter will have a power of 1500W and is normally used by Cable and Wireless, but on this occasion will relay the domestic mediumwave service from Jamestown, the capital of St Helena.

USA: According to *Radio World* magazine there are 4909 mediumwave and 5306 FM stations on the air in the United States. There are 20 shortwave stations which include VOA and private broadcasters which operate a total of 78 transmitters, and along with VOA Marathon in Florida, this makes a staggering total of transmitters operating in the United States.

WWCR, Nashville has been heard on 3290kHz with the usual gospel programmes at 0800UTC.

The expansion of the mediumwave band in North America to 1700kHz has resulted in two stations being heard on this expanded band. First to be received was WJDM, Elizabeth, New Jersey operating on 1660kHz with 1000W night-time power and this station verified our reception promptly. The second station to operate is KXBT, Vallejo, California which was previously on 1640kHz but on the 27th of April the FCC requested that the station move to 1630kHz. The power of the station is 10kW day and 1kW night, and they relay their original outlet on 1190kHz, verification signed by 'Ralph'.

The address of the station is 3267 Sonoma Boulevard, Vallejo, CA 94590, USA. ❖

This item was contributed by Arthur Cushen, 212 Earn Street, Invercargill, New Zealand who would be pleased to supply additional information on medium and shortwave listening. All times are quoted in UTC (GMT) which is 10 hours behind Australian Eastern Standard Time and 12 hours behind New Zealand Standard Time.

DIGITAL SATELLITE TV: WAVE OF THE FUTURE?

Viewers in many areas of the USA have been able to receive Pay-TV programming for quite a while, via either cable or C-band satellite broadcasting. But now *everyone* on the North American continent is potentially able to receive digitally encoded signals from the new high-powered satellites — using antennas the size of a family pizza.

by TOM MOFFAT

What's the hottest-selling consumer electronics item in America today? It's certainly not VCRs, or the new digital camcorders, or multi-media personal computers. The latest 'must have' item is a little satellite dish the size of a family-sized pizza. Yet it can receive up to 200 channels of TV while it is pointed at the one place in the sky. The system is called DBS, or Direct Broadcast Satellite.

When I first saw one of these little dishes, I thought there's no way in the world it could work. Back in Tasmania, to get any kind of picture at all from a satellite, a three-metre dish was the bare minimum, and true enthusiasts would go to a four or even five metre dish. Even then, pictures were noisy and shaky, not what you'd call crystal-clear quality.

Yet the mini-dishes used here in the USA produce pictures of what is claimed to be better than broadcast quality (at least better than NTSC), and they're even claimed to be ready to go when high-definition TV (HDTV) becomes a commercial reality.

How can this be? Well, it's simply a matter of overcoming path loss — the effect that causes all radio signals to eventually become too weak to receive. On a normal satellite link the satellite transmitter is fairly weak, only a matter of a few watts. Power is built up on the receive end through the use of a large parabolic antenna that provides many dB of gain.

A technician holding one of the DSS receiving dishes made by RCA. Thanks to high power satellite transponders and the improved performance of digital transmission, they're particularly small and light.

With the new DBS, the satellites contain whopper transmitters so the receiving antenna can be correspondingly smaller to provide the same overall path loss. In addition the signal from the satellite is in digital instead of analog form, so a picture can be reconstructed from a much weaker signal. The digital signal is also *compressed*, so that the signal's bandwidth is dramatically reduced. This further helps to overcome path loss, so that a pizza-sized receiving dish becomes practical.

In the USA there are at least three digital DBS services now running simultaneously from the same spot in the sky. These are DirecTV, USSB (United States Satellite Broadcasting) and PrimeStar. The first two services use 18-inch (46cm) dishes at the receiving end, while PrimeStar uses one twice that size — just under a metre.

With DirecTV and USSB, subscribers buy their receiving equipment outright and then pay a monthly or yearly fee for using it. With PrimeStar, hire of the equipment is included as part of the monthly service fee.

Technical details

Since DirecTV and USSB use such small dishes, they are more interesting from a technical point of view, so we will concentrate on them. The transmitting end consists of a group of three satellites: DBS-1, DBS-2, and DBS-3, all located at 101° west longitude. These satellites were made by Hughes Electronics, which also owns a big chunk of the DirecTV company.

DBS-2 and DBS-3 each have 16 transponders of 120 watts each, running in the Ku band (around 10GHz). These have been configured as eight transponders of 240 watts. DBS-1 delivers about 60 channels for DirecTV and 20 channels for USSB. DBS-2 and DBS-3 are used exclusively for DirecTV, giving that service an overall capacity of around 175 channels. This can be easily increased in the future. There are also about 40 sound-only channels delivering CD-quality stereo music.

All this flood of digital information has to come from somewhere, namely a small town called Castle Rock about 50km south of Denver, Colorado. Astute *EA* readers would have heard of this town before — it was the receiving location for Nikola Tesla's wireless power transmissions from his lab in Colorado Springs. One of Tesla's dreams was a broadcasting service carrying hundreds of programs simultaneously, and now somebody's gone and done it, right on his site!

The Castle Rock complex is very much like a TV station, although much bigger since it has to do up to 200 video and audio feeds simultaneously, around the clock. Even with its staff of 180 people, most of the facility is automated. The raw

Spot the satellite dish! A typical DSS antenna installation in Port Townsend, Washington.

programs come from a bank of 300 Sony Digital Betacam videotape machines. Their outputs are made available to a 512 input by 512 output routing switcher, which sends the right programs to the right channels.

Most of the control comes from a MEMEX computerised scheduling system that provides taping and dubbing information to human operators. It also produces broadcast logs and other essential revenue-generating information. It is also possible, through the operations centre, to individually address every one of the millions of decoder boxes in the hands of users. This is how various service options are energized. The output of the whole facility feeds to 54 high-powered satellite link transmitters.

It is obvious that with something like 32 satellite transponders and 175 channels, there's some fancy digital multiplexing going on — resulting in between four and eight channels sharing each transponder. This is all sorted out in the magic box on the ground that connects to the 18" dish. Each transponder is receiving and sending a data stream at up to 30 megabits per second, not forgetting the MPEG-2 compression, so the subscriber's decoder box is rather busy.

Innocent little box

You'd never know by looking though; the integrated receiver/decoder (IRD) unit looks like any other consumer electronics gadget; nothing special at all. The IRD, together with the funky little dish and its feedhorn, make up the total user end of the DSB system.

From the consumer's point of view, it's known as a DSS (Digital Satellite System). These are currently sold by both RCA and Sony, and the street price here in the USA is around $600 all up. Toshiba, Uniden, and other suppliers are expected to join the boom before the end of 1996.

It's interesting to note that the DSS receiver has been designed so that any idiot can install it, and around 40% of buyers do handle their own installations. Mounting the dish is very easy because it's so small — screw in four bolts and you're done.

Correct microwave dish alignment has traditionally been an advanced technician's job, but DSS has fixed all that. All you have to do is feed the IRD your latitude and longitude, or even your postcode, and the internal computer comes back with azimuth and elevation figures. You move the dish to the calibrated marks on the mounting, and you're almost done. For final tweaking there is an on-screen signal level meter, combined with a beeper system so you can watch the dish instead of the screen while you make adjustments.

The DSS setup procedure is so quick and easy that many people carry a system with them when they go on holidays. They are especially popular with owners of those enormous RV's (recreational vehicles) that are like a house on wheels.

It is not uncommon for an RV to turn up at a campground and disgorge a load of kids while dad sets up the satellite dish on a nearby picnic table. One wonders, however, why people would spend the time and money to drive to somewhere like Yosemite or Yellowstone National Park, only to spend most of their holidays watching telly in the RV...

When you get your new DSS system, the only signals it can deliver are a couple of 'ballyhoo' channels extolling the virtues of DSS programming. But to see the real thing, you have to pay up. There are many different 'plans' for different channel combinations, and you'd have to be pretty wealthy to afford all 175 channels.

So you make a quick phone call, credit card in hand, and soon the control centre in Castle Rock sends a message through the satellite system to your very own receiver, telling it what channels to allow through and what channels to block. Should you stop paying, another message comes through telling your receiver to block everything.

Inbuilt modem...

Pay-per-view programs, such as feature movies and sporting events, can be ordered up instantly. For this to work your IRC box must be connected to a phone line (there is a built-in modem). When you suddenly discover that an interesting movie starts in a couple of minutes, you zap the on-screen listing with your remote control. The computer then phones a toll-free number in Castle Rock and says 'let this guy watch this movie'.

Immediately a signal flashes back through the satellite link to your individual decoder, unlocking that channel only for the duration of the movie. At the same time the fact that you've watched it is stored on a 'smart card' within the decoder box. Once a month, in the middle of the night, your IRC again rings Castle Rock with billing information for the past month's pay-per-views. Movies cost about $3 apiece.

It's obvious that for this system to work you're going to have to be near a telephone. If you're sitting in your RV on some desolate mountaintop you can still watch normal channels, but pay-per-view is out. However if you're near a phone, such as in a campground, you can manually ring a 1-800 number, give them your subscriber details, and ask for the movie. There's an extra charge of two bucks for this.

DSS reception is available in all of continental USA, including Alaska, which is so far from the Equator it's a wonder the state gets any satellite signals at all. Alaska is separated from the rest of the US by Canada, so signals are available in that

country as well. But receiving them is illegal, since DSS is not licensed to deliver TV signals into Canada by the Canadian Radio-Television and Telecommunications Commission.

All the same, it's estimated that between 5000 and 20,000 Canadians are receiving DSS. This is done by using a fake American mailing address, and several enterprising US companies have been set up for this express purpose. The DSS company mails documents and bills to your American address, and they're forwarded on to Canada. Hooking to a phone line is more of a problem because Canadian STD codes are instantly recognisable.

Many Canadian viewers simply do without pay-per-view, or they use the manual method of phoning the service provider to order each movie. However DSS suppliers have Caller-ID on their incoming 1-800 lines, but other companies have been set up in the USA to receive an incoming call and relay it out again from an American STD code.

The signals slop over into Mexico as well as Canada, with the same legality problems. But many Mexican viewers are 'illegally' enjoying DSS using the same methods as the Canadians.

Another thriving industry has built up around bootleg decoder cards, programmed to receive every DSS channel without the viewer paying a cent. This suggests that it might just be possible to receive American DSS signals in the South Pacific. The satellite's beams are of course centred on the USA, but with those powerful transmitters it may be possible, with a substantial dish, to receive and decode the signals in Australia or New Zealand. The satellites are in geostationary orbit over the equator due south of Mexico.

It appears that the bootleg decoder cards are RAM-based, and DSS operators can instantly solve their piracy problems by simply sending code down the satellite that zaps the pirate card's programming. This is apparently a frequent occurrence, known as a 'search and destroy' operation.

A DSS antenna clamped to a picnic table next to a typical US 'recreational vehicle' ready for a night's Pay TV entertainment.

A DSS demonstration stand at a US electronics retailer. The program being displayed is the weather channel. Note the wide range of program material available.

What you get

Is DSS worth it? The picture quality is indeed excellent, rivalling the quality from laserdisk. The sound is also very good. As for program content, it's broken down more or less as:

70 Channels of major cable services
30 Channels of subscription sports
20 Channels of special interest/niche services
50 Channels of Pay Per View (PPV) movies

The major cable services include such favorites as CNN, American Movie Channel, TNT (Turner Broadcasting), and documentary channels such as Discovery Channel and the Learning Channel. These last two carry Australian content such as Beyond 2000 and Quantum, and they supply some of the programs you see in Australia on SBS and the ABC, such as Nova and Frontline.

Among the 30 channels of subscription sports, there will probably be coverage of just about any sporting event any time of the day or night where a TV camera is present. Some publicans are latching onto this service, installing DSS systems connected to enormous monitors in the main bar.

Here in Port Townsend, one enterprising publican is featuring Seattle Mariners baseball games which are blacked out on the local Seattle stations. So on a Friday night he can fill the pub with-

out the expense of hiring a band. It's a pity in some ways, because what were once great music venues are turning into sports bars, as has happened with Sky Channel in Australia. All it costs is the price of the DSS receiver and dish, along with something like $600 a year to unlock all the sports channels on DSS.

One wonders about the legality of this; DSS is supposed to be a domestic in-the-home service. To use it in public performance to generate a profit must have interesting copyright implications.

Special interest channels include such goodies as one that shows mostly old science fiction films from the 1950s. Another might concentrate entirely on cooking shows, and yet another shows nothing but continuous weather forecasts. But no matter what their target audiences, every one of these channels seems to have plenty of commercials. You pay big bucks for the service, but you still get the commercials...

There are several grades of service offered by each DSS supplier. Basic grade gives you a moderate selection of cable and special interest channels. A higher grade throws in some premium channels such as Home Box Office, and on top of that you can subscribe to the sports channels. A basic service starts at around $30 a month, and you can add on from there. As you can see, if you're a real television addict you could end up spending an awful lot of money on it.

One thing missing from DSS is local programming. If you want to see your home-town news or current affairs programs, you're out of luck with DSS since all programs originate from the one place. So most DSS systems are designed to run in tandem with an off-air antenna system, to supply the local channels. You still see big holes, though, such as when the Weather Channel says 'And now it's time for your local weather'. On a cable-based system, the local cable company plugs in a character-generator weather summary at this time. Watching DSS you just see a blank screen.

Way of the future?

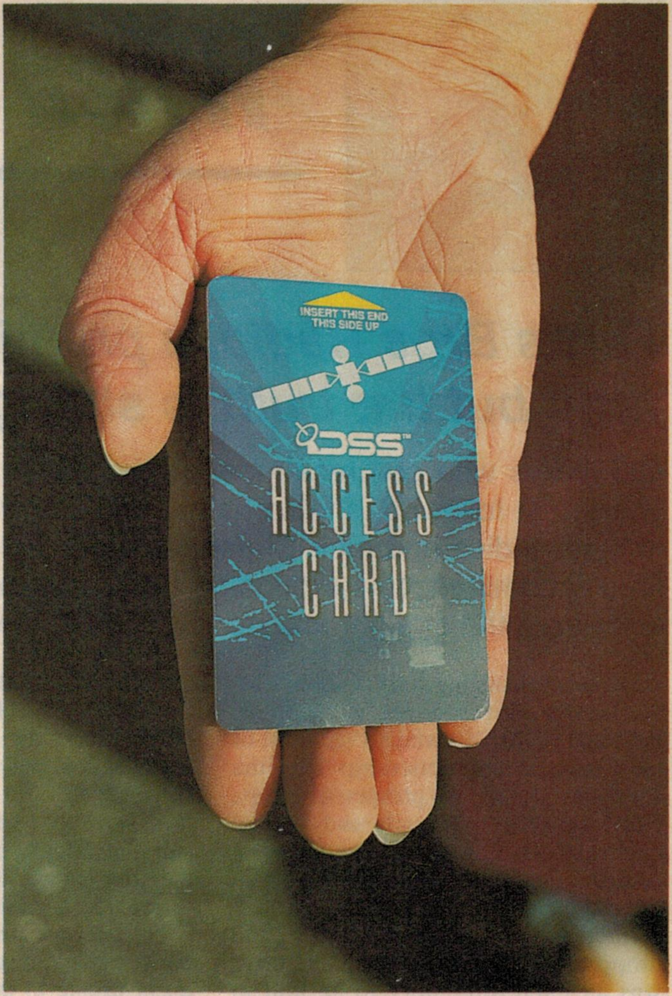
Promoters of DSS say it will be the ONLY method of television distribution in the future, replacing both cable systems and free-to-air TV. They may be right, but here in the US at the moment the cable companies and the DSS suppliers are in a tooth-and-nail battle for the hearts of TV viewers. It seems a new discount offer pops up every night on free-to-air TV, offering cut rate cable installations or DSS systems. Are the free-to-air stations slitting their own throats, advertising their competitors? Probably not.

There's a cable system of around 30 channels here in Port Townsend. What's there to watch tonight, a Wednesday, at prime time around 8:00?

Well, the Learning Channel has Ultrascience, which is sometimes all right once you get past all the 'gee whizz' stuff. Not in the mood for that tonight. Nickelodeon has reruns of *That Girl*; no, thank you. Back on the free to air Seattle channels, PBS has *Monsters of the Deep*. Hey, that sounds like me, so it will probably fill the 8:00 time slot in this house — if I can be bothered to turn it on.

Looking at the DSS listings, it's just more of the same. Fine Jewelry Showcase? That's on HSN, Home Shopping Network, which is really one continuous gigantic commercial. The Sci-Fi channel has *Twilight Zone*, but I've seen just about every one of those. What can you say? A hundred and seventy five channels, and nothing much to watch...

So from my point of view, I don't think I'd sign up for DirecTV or USSB, or PrimeStar just now. Technically they are absolutely great, but who wants to see boring programs with stunning resolution and brilliant colour? The music channels might be nice, but they're up against some of the finest FM broadcast stations in the land here, coming into Port Townsend from three directions — Seattle, and Victoria and Vancouver in Canada.



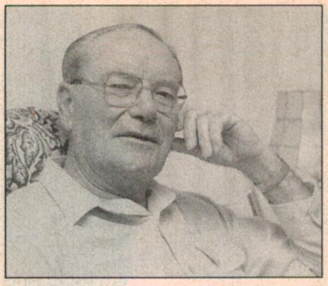
The DSS smart card, used by subscribers to gain access to the various channels and programs. It fits into a slot in the set-top receiver-decoder.

Even with the cable and all the satellite options, it seems the most popular TV system here is a combined VHF-UHF antenna with a rotator. You can also get TV from all the above-mentioned cities, and some of the Canadian stuff is truly excellent. But even then there are weak spots.

The Canadians like to produce revue shows like Australia's *Late Show* and the D-Generation. But in this field Australia still has Canada beaten hands down. Same goes for all the science and documentary stuff (David Suzuki excepted), which probably explains why there's so much Australian content in these areas.

Will DSS ever come to Australia? Given the present state of the art, it's not very likely. For DSS to be economical, there must be many millions of viewers distributed more or less evenly beneath its coverage area. In Australia the population is concentrated in the coastal cities, with the interior relatively empty. And DSS wouldn't make much money pumping signals into a herd of goannas.

So, Australian readers, you can sit there and drool over that big bird in the sky pumping 175 channels into American homes. But so much of it is dross; you're probably better off sticking with what you've got. Should local TV production in Australia be swamped by international broadcasters with DBS satellites, it would be a sad loss to all. ❖



When I Think Back...

by Neville Williams

Ferris Bros Radio, a prominent Australian firm: but the truth is stranger than fiction! (1)

Old timers who can recall the 'golden years of radio' and of black and white TV during the years that followed, should have no difficulty in recalling Ferris Brothers with their pace-setting car radios and their Channel Master TV antennas. What you may not know are the parlous circumstances surrounding the Company's initial foundation, and its subsequent deviations from the straight and narrow path of electronics.

For this fascinating story, I am indebted in the first instance to John P. Emanuel (VK2EJP) who served most of his formal apprenticeship in the Company during its prosperous years. Now, along with his wife and son, he operates John P. Emanuel Pty Ltd, specialists in automotive electronic servicing (fax/phone (02) 871 8230).

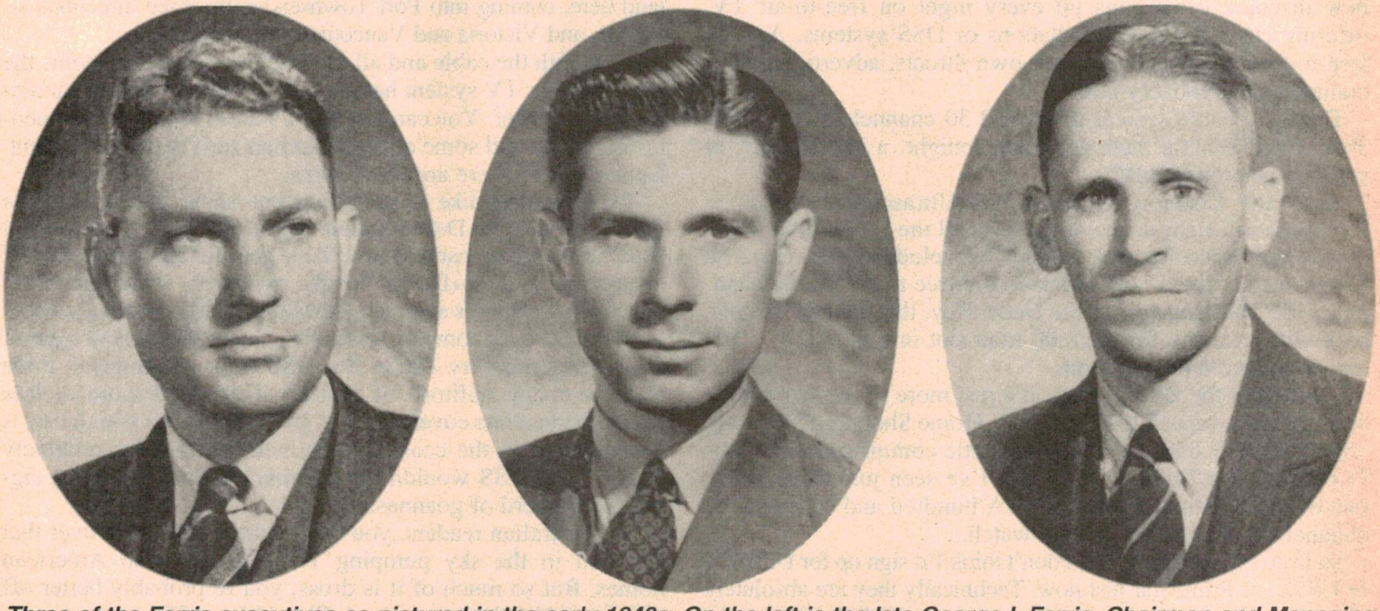
Back in September last, John dropped me a line suggesting that there was an interesting story to be told in 'When I Think Back' — to do with Ferris Bros. More to the point, he knew W.M. ('Chum') Ferris well, and volunteered to contact him on my behalf, to seek his cooperation in the preparation of an article for the magazine.

Back in the old days, I remembered Ferris Bros as a very businesslike organisation, and Chum's reaction was still true to form even in his eighties. Yes, he would be delighted to see the story in print and, rather than rely on memory, would check through his files to provide documented facts.

The package I received, in an original Ferris cardboard carry carton, was an eloquent tribute to the staff who, over the years, had prepared the printed matter that emanated from the organisation — from advertising and handbills to data sheets and complete service manuals. Their collection consumed rather more time than Chum had anticipated, because each new file opened another window on the past and refreshed the memory of personalities far too numerous to permit individual mention in the proposed story.

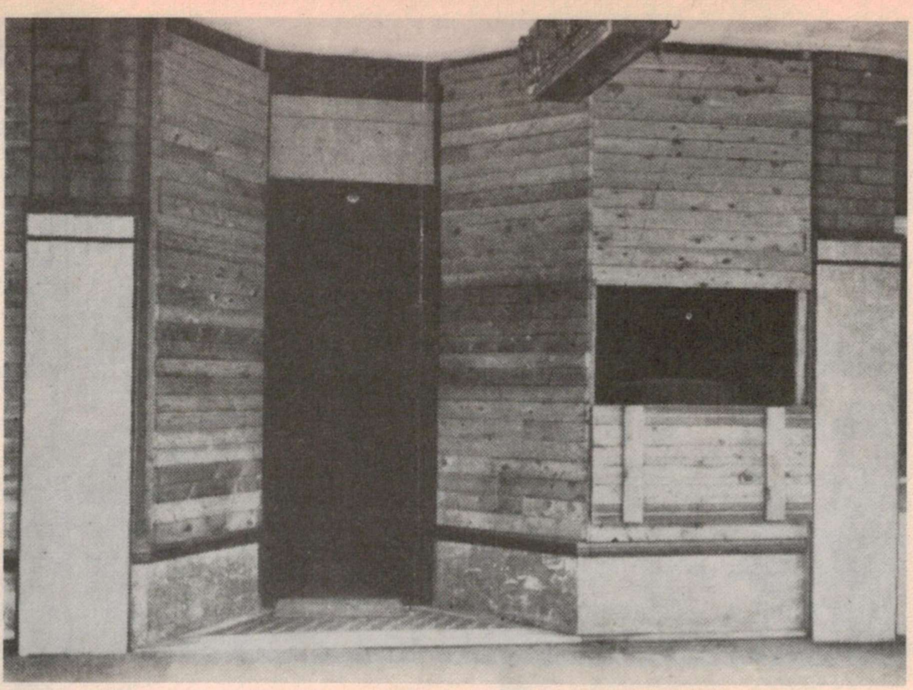
Thank you, Chum, for your thoroughness and for your obvious awareness that history ideally starts at the beginning: 'Once upon a time...'

In keeping with that observation was an historic Company brochure entitled *After Seven Years*. In the form of a Directors' Report, it carried an annual financial statement for the period July 1, 1942 to June 30, 1943. Elsewhere in the brochure and more relevant to the present exercise was a summary of the



Three of the Ferris executives as pictured in the early 1940s. On the left is the late George I. Ferris, Chairman and Managing Director. In the centre is W.M. ('Chum') Ferris, company founder and Technnical Executive, then in his early 30s. On the right is Mr E.S. Wyatt, who joined in the mid 1930s and helped pilot it from a struggling family business into a registered company.

In 1935 Ferris Bros. Radio opened for business in this unimpressive shop in a residential environment in Mosman, NSW. Company assets were 126 pounds in the bank, an old Hupmobile car, a small kit of tools, two ambitious brothers and a supportive family.



Company's affairs for the initial seven years — right from start-up.

What it doesn't mention is that 'Chum' Ferris had been exposed initially to the so-called radio 'bug' in his early teens, at Noyes Bros, Philips and AWA. The outcome in his case was an urge to establish a radio business of his own...

The shadow on the Great Depression still hung over Australia when Ferris Bros. Radio opened its doors for business in October 1932. Looking back, Chum Ferris is amazed that the venture survived at all for more than a few weeks. It occupied a very small shop in an out-of-the-way position in Mosman, Sydney, which had to serve both as a showroom and a service centre.

Brothers' dream

From the outset, the plan was to manufacture and sell their own brand of radio receivers, as well as distributing and servicing as many other brands as might become available.

The staff comprised just two people: Mr W.M. ('Chum') Ferris, Manager (aged all of 18 years), and a 'boy' assistant. Beside the tiny rented shop they had access to an ancient Hupmobile tourer, belonging originally to Chum's elder brother George and notable for its thirst for fuel — plus a tendency to leave behind blobs of oil whenever it was parked for any significant length of time.

In conversation, Chum recalled that he had fitted it out with a radio set, although not a car radio in any formal sense of the term. A traditional battery set powered by ordinary batteries and housed in a metal box, it was fed from an aerial wire strung back and forth under the fabric hood.

Primitive though it might have been, Chum said that it was probably the seed from which sprang subsequent generations of Ferris Bros' car radios, caravan and farm radios, portables and 'small-ships' marine equipment.

In the meantime, by the time they had purchased the bare minimum of equipment and stock to open the doors for business as planned, the cash balance at the Bank stood at five pounds — $10 in today's coinage. In practical terms that meant that they had to build radio sets one at a time, selling each one before they could purchase the parts to build another!

In 1933 the opportunity came to move to better premises in Military Rd, Mosman; while not much larger than the original shop, it was at least in the retail area and had previously been a radio shop. Business gradually improved, sufficient to justify the addition of a man to the staff on a part-time basis, to look after the books and 'mind the shop' whenever Chum's mother wasn't available.

During 1934/5 Mr G.I. (George) Ferris, Chum's brother, invested money in the business, which helped to buy additional plant and stock and to finance modest advertising. At the time he had been working meantime for CSR in New Zealand and Fiji.

Modest progress

In fact, 1935 proved to be an important year, with business reaching a level which justified the purchase of a new Chevrolet panel van. Its appear-

The later Mosman Store as pictured in 'After Seven Years'. Flanked by other shops in a commercial situation, it offered electrical as well as radio service and expanded later to accommodate workshop facilities on the floor above.

Ferris Bros. factory and head office as set up in 1942 in Dowling St, East Sydney. In this situation they diversified into vehicular service which became significant under wartime conditions.

ance on the street in place of the dilapidated old Hupmobile indicated to local residents that the Ferris Bros store was making headway.

No less to the point, the title 'Ferris Bros' gained a still further dimension when G.I. Ferris returned to Australia and joined the firm as an active partner, raising to five the number of employees on staff. In the following year, there was a further move to 932 Military Rd, Mosman.

In 1936, it was evident that more capital would be necessary if the Company was to expand any further, and steps were taken to register the Company with G.I. (George) Ferris as Managing Director. Within a very short time 1300-odd shares were taken up, some by former friends in Fiji and New Zealand, and a third director (non-executive) was appointed in the person of Mr E.S. Wyatt.

At that stage, the Company began to move in a positive way, taking up a floor above the shop such that, for the first time, it had separate and dedicated space for a showroom and a factory/service facility.

To broaden the activities further, the directors decided to offer electrical servicing, with an initial arrangement to delegate any work to a licensed electrical contractor. The scheme worked well enough for a while, but it became apparent that Ferris needed qualified on-staff electricians — and finished up with no less than four of them, working full time.

But the major decision taken by the directors in late 1936 was to become involved in the manufacture of car radio receivers, for which there appeared to be an unsatisfied demand. When they addressed themselves to the design, however, they encountered the kind of technical difficulties which had deterred other local manufacturers from exploiting the market. Two years were to elapse before Ferris had a basic design about which they could feel confident.

War intervenes

In 1938, following a share issue, Ferris Bros opened Car Radio Australasia in William Street, Sydney — an area which had a traditional association with automobile distributors and suppliers. In 1939 they exhibited at the Royal Easter Show and to their unbounded delight, took sufficient on-the-spot orders to cover the outlay on the stand.

In normal circumstances they could have expected sales to build sufficiently from there on to absorb the total cost of the launch, but war had been declared and buyers had become very cautious as a result. There was talk of the radio industry being put on a war footing, and a rising tide of speculation about petrol rationing.

Car Radio Australasia nevertheless repeated their exhibit at the 1940 Royal Show, but while there was no shortage of 'lookers', they were clearly not inclined to buy. Ferris Bros 'got the message' and closed down the William St. Depot in June of that year, although not before its initial profits had been dissipated.

Making producer gas?

Talk of petrol rationing had triggered spirited debate about alternative sources of supply, but current wisdom at the time was that Australia lacked petroleum resources of its own — beyond a few dubious shale oil deposits, as at Newnes and Mittagong in NSW. Maybe, just maybe, road vehicles could be converted to run on producer gas, as were a few combustion engines on outback properties, where charcoal was more readily to hand than motor spirit.

(That observation obliged me to 'think back' to my own country days. No, 'charcoal' didn't signify the ash left-over in the domestic stove or grate but, as a potential fuel, represented — I quote — 'the carbonaceous residue that results from the incomplete combustion of wood or other organic material'. I have recollections of people contriving kilns in the local bushland, to obtain 'fuel' charcoal for whatever reason; for example, for use in the blacksmith's forge.

I also have vague memories of the occasional local truck or car, with what looked like an oversize camp oven on the rear tray or luggage rack. It was, in fact, a 'producer gas' generator powering the engine in lieu of petrol vapour. While neither convenient nor particularly efficient, it was presumably preferable to an empty fuel tank!

To refresh my mind on how the system worked, I turned to a family encyclopaedia issued back in the 1930s. A producer gas generator, I discovered, contained a readily flammable ignition layer topped by a deep layer of charcoal. Air was sucked up through the device by a pipe connected to the intake manifold of the engine, with an intervening filter to protect the engine from solid particles.

To get the system going, the engine had first to be started on petrol, either from the normal tank or by gravity feed from a small auxiliary tank under the bonnet. Having thus set up suction via the intake manifold, the flammable layer in the producer was ignited, thereby igniting the adjacent charcoal and creating a high-temperature combustion mix of nitrogen and carbon dioxide.

In the environment of (very) hot gas, the upper layers of charcoal robbed the carbon dioxide of an oxygen atom to become carbon monoxide, an unstable — and poisonous — gas which could power the engine in much the same way as petroleum vapour. The petrol could then be turned off, leaving the engine to rely solely on carbon monoxide.

Given an adequate supply of charcoal and a resonably alert driver, vehicles could travel normally intracity and intercity. Chum Ferris recalls that he drove to Port Macquarie for his honeymoon, over 400km plus vehicular ferry river crossings, in a 1936 Ford V8 — on producer gas!)

What, you may well ask, has this to do with Ferris Bros Radio? Well... faced with rented premises and product lines with an uncertain future, the directors began to speculate as to whether there might be a market for producer gas units for everyday road vehicles.

No one seemed to know much about them, but they appeared not to present too much of a problem in terms of metal fabrication. The 'bits' could be made by contract metalworkers and assembled wherever space was available — without publicising what the company was up to and motivating potential competitors!

Even so, at about this point in time, the directors were contacted by a man who claimed to know more about producer gas technology than anyone else in Australia. Unfortunately, such was the level of formal expertise on the subject that he might well have been telling the truth, without being any kind of an expert, himself! Progress, nevertheless, was painfully slow.

At the outset, the only source of charcoal in Sydney was from an experimental Government site at Pennant Hills. Failing to obtain an adequte supply, the 'expert' suggested that Ferris provide their own; said he: "There's nothing to it"!

Accordingly, they dug a couple of large pits at the rear of the Mosman premises. In a climate of wartime sensitivity, this soon triggered a visit from the police, to see what they were up to!

When the pits were duly loaded with fuel and logs and ignited, they began to emit large volumes of smoke — which steadily increased in density over the next 48 hours, to blanket the entire suburb. Councillors and officials became agitated, and were unimpressed by assurances that the Ferris Bros were involved in a confidential wartime research project!

Success at last

The best that can be said was that, some 48 hours later, Ferris Bros had cooked enough logs and created enough charcoal to complement their efforts to develop a practical producer gas system. (They note, however, that charcoal production was never again attempted in the fair suburb of Mosman...)

Meanwhile developmental work continued night and day on gas producer No.1, and it was eventually strapped to the rear of a test car by removing the boot lid and securing the gas pipe along one side to the engine. Access to the vehicle was impeded and the driver had no rear vision. Gas was certainly generated, sufficient to support a naked metre-long flame from the producer, but none of it, alas, appeared to have reached the motor.

Units number 2 and 3 followed, registering further progress but not success. Unit 4 did gain State Government endorsement, being the first to do so in NSW, for an ordinary passenger vehicle. By September 1940, some 40 of the units had been assembled or completed — only to be faced with a change in Federal Government, which promised a petrol rationing scheme so liberal that few motorists would need a producer gas generator, anyway!

In the months that followed, Ferris Bros were hard put to it to keep their doors open. But then the position changed again, with the NSW Government actively supporting the fitting of producer gas systems at the Royal Easter Show in 1941. 1941/42 emerged as a bumper year for the Company, such that they opened new automotive premises in Dowling Street, City, not far from the earlier venture.

This time, they were determined to major on producer gas equipment sales and service for as long as it might last — diversifying to electrical contracting, automotive work and car radio as necessary to keep the staff occupied. The Head Office and general sales organisation was also re-located in the same building. To embrace the wider activities, the name was changed to Ferris Bros Pty Ltd.

(In practice, a significant number of producer gas units were ignited only rarely. For much of the time they served to conceal the fact that the driver was really running on blackmarket spirit!)

Be that as it may, the brochure *After Seven Years* ends on an optimistic note with the Company finances in a healthy state and a conviction that, after the war, there would inevitably be a more intensive call on the Company's varied services.

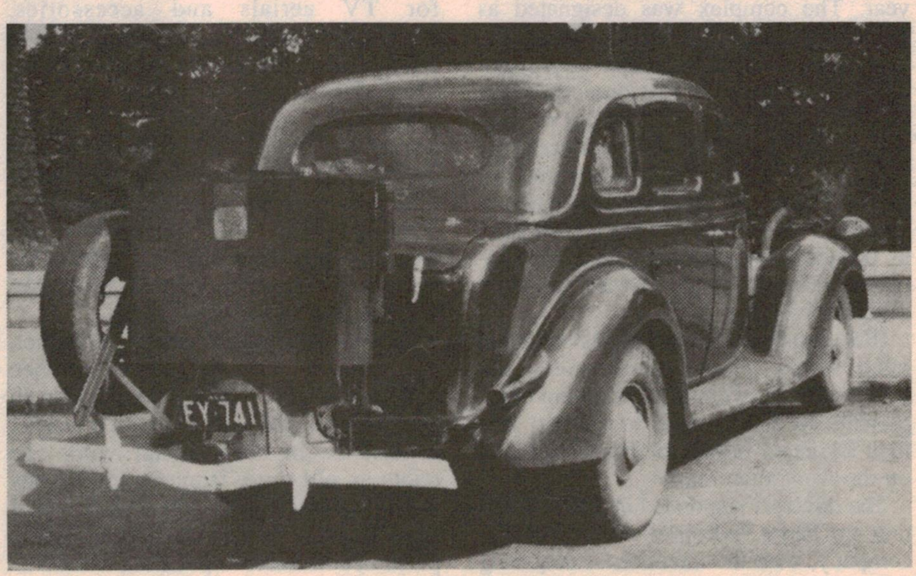
Even further from radio

Lest there be any reservations about my earlier reference to deviations by the Company 'from the straight and narrow path', the final segment in the brochure refers to a rural investment — a stud piggery in what is now the Sydney suburb of Blacktown. It was an investment in which Chum Ferris took an active role, adding: "Knowing how Blacktown has developed recently, can you imagine what the real estate value of that piggery would have been on present day values?"

Frankly, I didn't have a clue, but confessed to being more intrigued with another aspect of the Ferris Bros story: the *After Seven Years* brochure had surveyed activities of the Company up to mid-1943, but had made little or no mention of producing equipment for the armed forces. If nothing else, would that not have created a problem in terms of manpower?

Chum's answer was that things had simply worked out that way, with Ferris Bros' accepted role being, as he put it, "To keep the home fires burning".

With severe restrictions on the pro-



The contrivance on the back of this 1936 Ford V8 is not an extra luggage trunk, but Ferris Bros' Producer Gas Unit No.6, flanked by a re-positioned spare wheel, bumper bar and number plate. Using a vehicle like this, 'Chum' Ferris drove to Port Macquarie for his honeymoon.

duction of new radio and electrical equipment, faulty items had to be repaired or reworked wherever possible. It was a task that Ferris Bros were well equipped to handle, extending beyond domestic equipment to marine receivers and transceivers.

With a team of licenced electricians, they were also well placed to cope with problems involving 240V mains operated equipment, including mains powered refrigerators and industrial equipment.

Their involvement with producer gas equipment had direct implications for both State and Federal Governments, and also extended to a role in vehicle servicing. Far from frustrating Ferris, the Manpower Authorities cooperated in their efforts to maintain civilian services at a viable level — even as a primary producer supplying pork to the breakfast table! (They became an accredited supplier to American troops in the Pacific area.)

In line with their expectations, business built rapidly as the war drew to an end, with staff numbers reaching 120 by 1950. There was also an expanding network of distributors handling Ferris products and services throughout the Commonwealth.

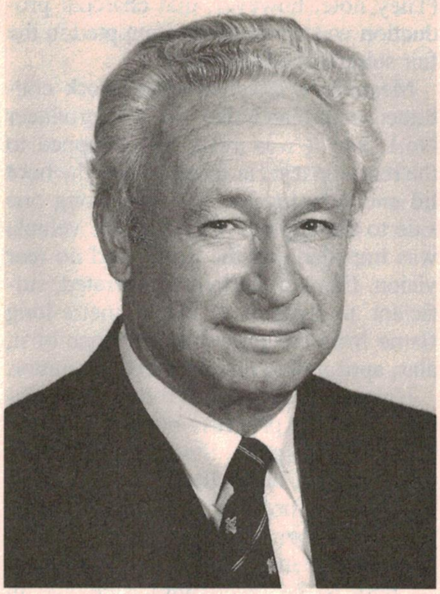
Ferris Bros postwar

In that same year Ferris Bros. Properties Ltd was formed, with the express purpose of erecting a modern factory for the manufacturing company, Ferris Bros. Pty Ltd. Keen to vacate the City address, the directors purchased a site fronting Pittwater Road, Brookvale, where they erected a new factory with a floor area of 14,700ft^2 (1370m^2). It was occupied in May 1953 and enlarged by a further 5000ft^2 (465m^2) in the following year. The complex was designated as their Head Office and Number 1 Factory.

In June, 1953 Ferris Bros acquired a controlling interest in Telecomponents Pty Ltd, with the idea of making use of their component manufacturing resources in the manufacture of Ferris car radio receivers. In fact, the Telecomponents section expanded in its own right, with direct sales to outside companies achieving an ultimate level many times the value of those absorbed by Ferris itself.

(For example, a catalog dated April 1969 offers power transformers and other machine-wound replacement components to servicemen, to suit no less than 21 listed brands of B&W TV sets on the Australian market).

The directors responded in 1955 by setting up Ferris Industries as the holding company, with the intention of acquiring the shares of both Ferris Bros and Telecomponents. The amalgamation paved the way for public company status, and the shares were duly listed on the Sydney Stock Exchange in 1956.



Born in Orange and educated at Newington College and Sydney Tech, G.M. (George) Holland served as a radar officer in the RAN and then Engineer/Management at Cockatoo docks. Joined Ferris in 1959, became Manager, then Chairman of Telecomponents, Board Member of Ferris Bros and subsidiaries.

In the meantime, negotiations were commenced in 1954/5 with two American Companies — Raytheon for manufacturing rights of TV receivers, and the Channel Master Corporation for TV aerials and accessories. Agreements were finalised in late 1955, following an extended visit by Chum Ferris to both companies.

From the very outset, the Channel Master Pty Ltd subsidiary was very successful. But efforts to develop and market a TV receiver ran into major problems with superseded stock, wasted time and energy — and especially, bad debts of the kind that ultimately scuttled firms like Admiral and Stromberg-Carlson.

To make matters worse, I gather, Ferris offered sets in a metal cabinet, American style — which they were well equipped to produce with their earlier experience in sheet metal work. To quote an old timer from the era: "They weren't bad little sets, but most Australian buyers were looking for a piece of furniture — polished wood!'

Better times ahead

TV receiver production was suspended in 1960, marking what George I. Ferris, Chairman and Managing Director, nominated as a sad and bitter experience. He described it as the one fundamental error in planning that the Company had made since its foundation in 1932.

Curiously, I myself chanced to gain by their dilemma. About that time I had built a 21" TV set, as a magazine project and also for my own family use. I happened to drop into the Ferris factory and noticed a dusty 21" TV cabinet sitting forlornly in an odd corner. When I mentioned it, I was told that it was a sample that had outlived its purpose. If it was of any use to me, take it away — with our compliments!

So it was that the Williams family watched B&W TV of the era on an *R,TV & H* prototype chassis, in a cabinet styled for a Ferris/Raytheon model that didn't survive! (More about TV receivers in the next article).

Fortunately, other aspects of the Ferris enterprise continued to expand, to the extent that the Brookvale premises became totally inadequate. More land was acquired adjacent to Mitchell Rd, Brookvale, a quarter-mile from the No.1 factory and Head Office. There, a new factory was completed in 1956, offering an extra 28,000ft^2 (2600m^2) of space which was allocated initially to a tool room and machine, sheet metal and paint shops.

In due course, purpose-built annexes to the two factories and covered walkways occupied most of the intervening space, forming what old-timers from the organisation regarded as a third factory.

During the period 1958/59, branches had been opened in Melbourne, Newcastle, Wollongong and Brisbane; factory representatives were set up in a half-dozen regional cities, and wholesale distributors appointed in Perth and Tasmania. Ferris had strategic coverage nationwide, with the all-up staff level hovering around 700!

Ferris interests also spread overseas in the early 1960s with shares in Channel Master (N.Z.) Ltd., with other joint ventures in Malayasia and Singapore subsequently — in the latter case involving GEC.

If the Ferris brothers had been dismayed by their venture into TV set production, their losses had been more than compensated by the demand for components and services to do with TV antennas.

(To be continued) ❖

Finding Hidden Defects In On-Board Components:

WHEN IT DOESN'T SOUND QUITE RIGHT

When ICs and other components are packaged, faults can occur which until recently were very hard to detect — and were likely to result in catastrophic failure later in the life of the component and the equipment it was installed in. But recently a new technique has proven very effective in detecting many of these faults: scanning and imaging them with very high frequency sound waves.

by TOM ADAMS

As an integrated circuit (IC) proceeds through the numerous and complex steps involved in its manufacture, it becomes increasingly valuable in economic terms. This is why the manufacturers and assemblers of ICs like to find defects in the IC, or in its packaging or connections, as early as possible. At all costs they need to find defects before the devices are sent on their way to the eventual customer.

One of the final steps is the mounting of the packaged IC, typically onto a PC board. A populated board, which may be crowded with packaged ICs, resistors, capacitors, and other devices, is a high-value product, since it represents the sum of all previous production costs.

Manufacturers can easily test boards for chip-level defects, which are very tiny defects in the chip itself. It's much harder, though, to test for the other class of defects — those involving the black epoxy covering the chip, or the material attaching the die to the support 'paddle' (part of the lead frame) inside the package.

These hidden packaging defects are dangerous, because they don't cause an immediate failure and won't show up in electrical testing. But they get bigger over time. Eventually an internal defect (such as a crack in the epoxy) breaks the leads connected to the chip, cracks the chip itself, or performs some other mischief which kills the chip when the customer is using it, weeks or months after assembly.

Harnessing sound

A new technology takes advantage of the fact that most components are somewhat transparent to ultrasonic sound waves (ultrasound), to separate the good ones from the bad in a nondestructive fashion.

Briefly, computer commands guide the scan head of a reflection-mode acoustic microscope over each of the devices on a board. The scan head interrogates each device for internal anomalies, and makes a pseudocolour image of the interior of the device. Those devices having hidden defects are clearly identified, and can be replaced to produce a defect-free board. Sonoscan, the developer and manufacturer of acoustic micro imaging systems, calls the new system UltraBoard(tm).

Reflection-mode acoustic microscopes use ultrasound at frequencies between 10MHz (megahertz) and 200MHz. For comparision, human hearing can detect sounds at frequencies ranging from 20 to 20,000 hertz (cycles per second) — the latter being 20kHz. So the low end reflection-mode frequency of 10MHz is about 500 times the highest frequency you can hear...

As acoustic frequencies go up, the ability of sound to penetrate a given material goes down. (This is why whales use extremely low frequencies — below human hearing — to communicate through water over hundreds or even thousands of miles.) The reflection-mode frequency of 10MHz will penetrate, and give return echoes from, even the thickest IC package. If you imagine that the epoxy around the package is transparent, and that the internal features such as the die and the lead frame are semi-transparent, you'll have a good idea how an IC package looks to ultrasound.

The higher frequency of 200MHz might not penetrate through a really robust IC package; in practical terms, this means that the high frequency may not be able to image defects near the bottom of an IC package because the ultrasound doesn't reach that far. The higher frequencies have higher image *resolution*, however. The choice of frequency for a given IC package, then, is a balance between penetration and resolution, and might be 15MHz, 50MHz, 100MHz, or even as high as 200MHz.

How it's done

The board to be inspected is positioned in a water bath under the micro-

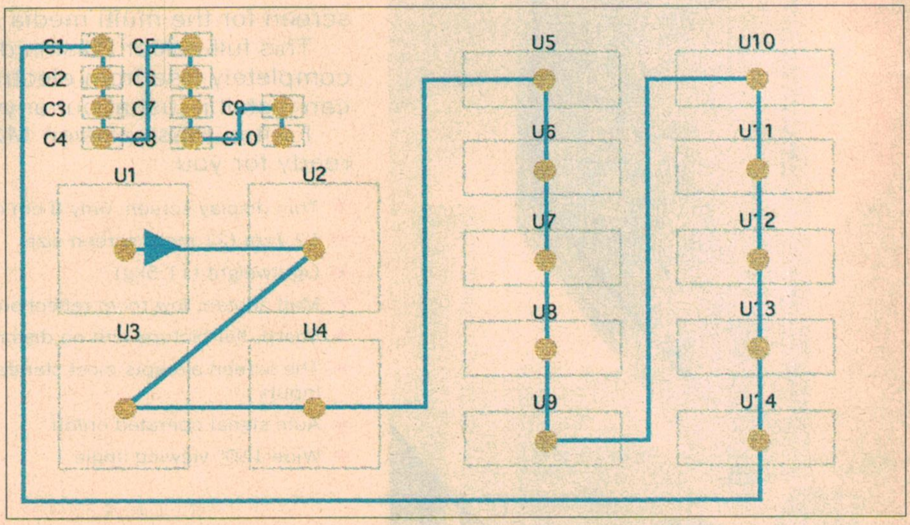
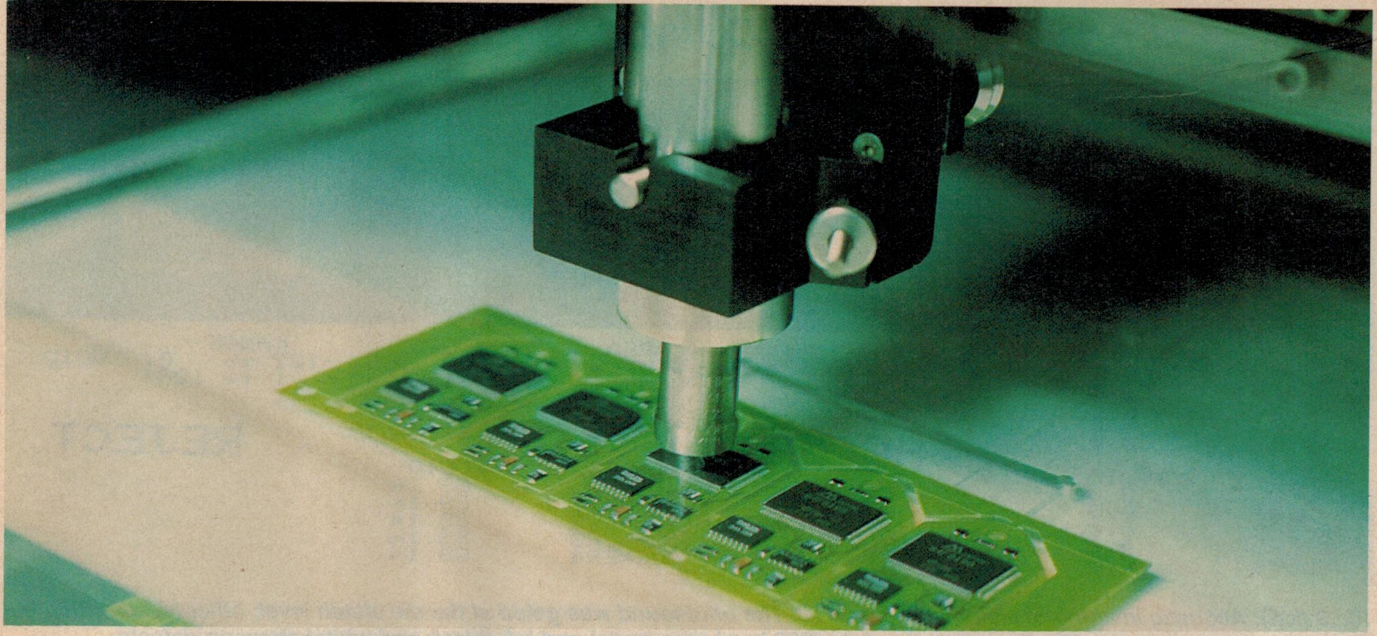


Fig.1: The ultrasonic scan head follows this track over this board, which had ICs of two different types and elevations, as well as ten ceramic chip capacitors.



scope's scan head. Water (or another fluid) is needed because the molecules in air are too far apart to transmit ultrasound. No electrical power is applied to the board during imaging. Boards with components on both sides can also be inspected — they're just flipped over to inspect the second side.

What does ultrasound do inside the IC package? At the centre of the package is the silicon chip, which is usually fastened by a layer of 'die attach' material to the metal die paddle beneath it. Metal fingers from the die paddle (the lead frame) extend in all directions; these are the leads which are visible at the periphery of the board-mounted package. Black epoxy is injection-molded around the assembly consisting of the die, the die paddle, and the lead frame, with the result that there is epoxy both above and below this assembly. The purpose of the epoxy is to protect the die from environmental hazards such as water and shock.

UltraBoard's scan head, poised above the IC package, delivers a beam of ultrasound into the package. The materials of which the package is made — epoxy, silicon, metal — are all relatively transparent to ultrasound. Just as important, these materials are arranged in layers, with interfaces between the layers.

Ultrasound from the scan head first hits the top layer of epoxy, and travels easily through the epoxy as long as there are no defects (such as a crack or a void). When the ultrasound encounters the interface between the epoxy and the die (the next layer down), it will reflect some of the ultrasound back to the scan head, where the return echo from this interface is received. Next the ultrasound travels through the die, and encounters the interface between the die and the die attach material. Again, some of the ultrasound is reflected back to the scan head.

These reflections from internal interfaces show up initially as spikes on an oscilloscope attached to the microscope. Return echoes from interfaces continue until the bottom of the IC package is reached, or until the ultrasound has reached its limit of penetration. Picture a ship's sonar pinging off of a series of semi-transparent objects placed one behind the other; ultrasound is doing the same thing, but on a micro scale.

The scan head moves back and forth over the IC package, collecting return echoes (data points) and sending the data to the computer which assembles it into a visible pseudocolor image on a CRT. If the IC package has no defects, its internal features — the die, the die attach material, and the lead frame — will all be clearly visible.

Sometimes, though, the ultrasound encounters a defect as it moves downward from the scan head through the IC package. There are several common types of defects: delaminations between layers, bubble-like voids in the epoxy, cracks in the epoxy, voids or disbonds in the die attach layer, and even cracks in the die. All of these defects have one thing in common — they are gaps in the material.

Unlike interfaces, gaps do not reflect just a portion of the ultrasound. Instead, they reflect *all* of the ultrasound back to the scan head. The return echo from an internal defect is therefore quantitatively enormous. This makes internal defects easy to image. In the CRT image, defects stand out strongly. The operator of the system can select the pseudocolours used in

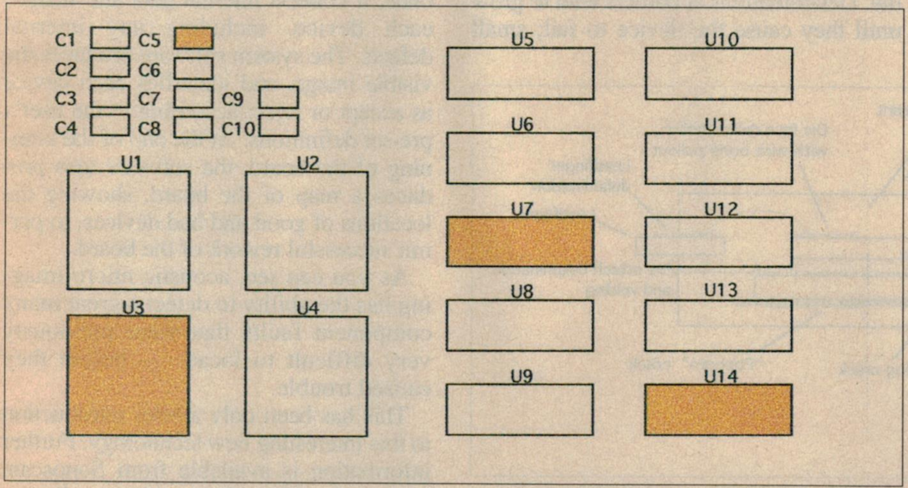


Fig.2: Acoustic imaging of the board gave this result: three ICs, and one ceramic chip capacitor, have hidden internal defects which are likely to impair the long -term reliability of the board.

Finding Hidden Defects in Components

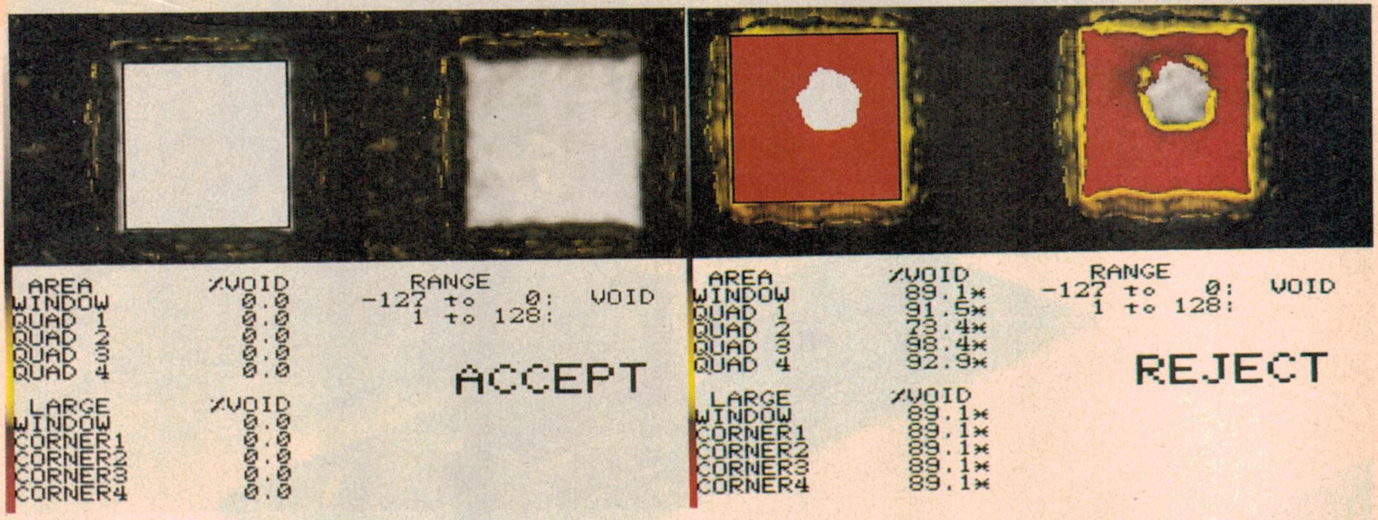


Fig.3 (left): Acoustic imaging of a single on-board IC. The ultrasound was gated at the die attach level; other levels within the IC package were ignored. The images at the right (256-level grey scale) and left (black and white) show no defects.
Fig.4 (right): This IC displays near-total disbonding of the die attach material. Only a small circular area is well bonded.

the display; almost universally operators choose to make defects bright red.

The ultrasonic echoes returning from the interior of the IC package are separated in time when they arrive back at the scan head. The UltraBoard operator can take advantage of this fact to gate the return echoes electronically. For example, if the die face is the internal level of interest, the operator will gate for return echoes from this level only. Echoes returning from other levels will be ignored in making the visible acoustic image. In this way automated operation can distinguish between a small non-corner die attach delamination, which is probably non-critical, and a small die face delamination, which may be very critical.

The system is typically used when a manufacturer has a quantity of boards known to have defective components. The operator of the microscope scans the first board manually to enable the system software to learn the X, Y, and Z position of each component. The components are usually IC packages, which may be of different types, of different sizes, and of different heights. In addition, the system can scan ceramic chip capacitors and some types of resistors. The total number of components to be scanned is unimportant; there's no upper limit, nor is there to the number of types of component.

The operator also specifies which anomalies are actually rejectable defects. A delamination in the die attach, for example, may not be a reject if the delamination is small and not located at a corner of the die. Delaminations at corners tend to grow until they cause the device to fail; small delaminations at other locations are more benign. System software measures the size of a defect as a percentage of the affected area; for example, it measures die attach delaminations as a percentage of the whole die attach area.

When these specifications have been set, the operator needs only to insert a board and begin the inspection sequence; scanning and imaging are automatic. Not only can the microscope find each device, it can even find devices which are slightly out of place. It does this by hunting acoustically for a 'signature echo' (generally the first internal echo) and using this echo to determine the real location of the device.

As the scan head moves over the board, imaging one device about every 15 seconds, it collects internal data and images each device, including any internal defects. The system software produces the visible image, and identifies each device as accept or reject according to the user's pre-set definitions. At the end of the scanning of the board, the software also produces a map of the board, showing the locations of good and bad devices, to permit successful rework of the board.

As you can see, acoustic micro imaging has the ability to detect a great many component faults that were previously very difficult to locate — before they caused trouble.

This has been only a brief introduction to this interesting new technology. Further information is available from Sonoscan, Inc., of 530 East Green Street, Bensenville, Illinois USA 60106; phone (+1 630) 766 7088, fax (630) 766 4603 or email **sonoscan@aol.com**. ❖

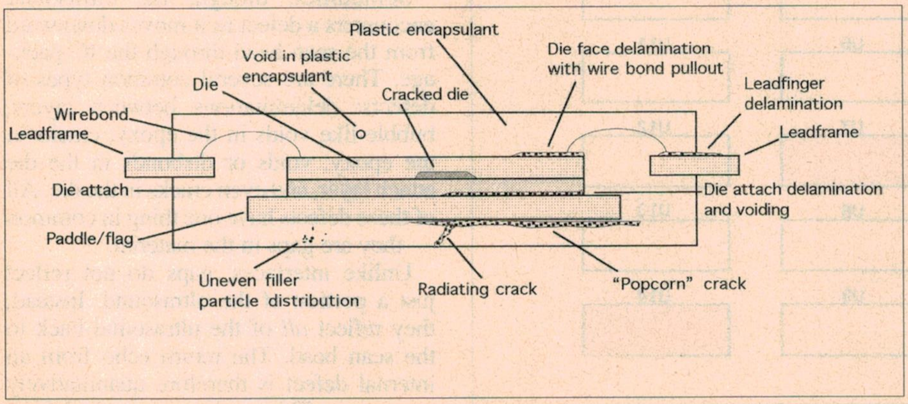


Fig.5: Numerous packaging related defects can impair the long-term reliability of a plastic-packaged IC. Die face delaminations and popcorn cracks (the latter often caused by the thermal shock of the mounting process) are common defects which may not be found by electrical testing.

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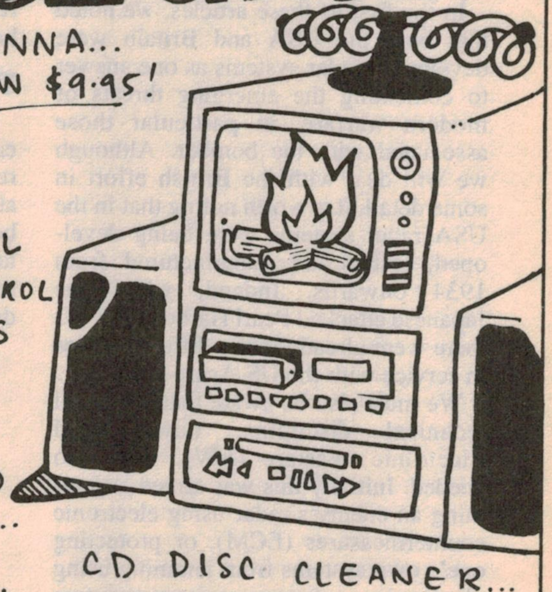

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A SHORT HISTORY OF EARLY RADAR - 2

In this second of three articles describing the development of radar, the author gives an overall summary of the operational requirements of military radar systems, and then reviews some corresponding major developments in a number of countries. Finally he summarises some of the outstanding basic developments which were, and still are, fundamental to the design of radar systems.

by JOHN BELL, B.E., M.Eng., F.I.E.E., F.I.E.Aust

In the first of these articles, we noted that both the USA and Britain were developing radar systems as one answer to combating the emerging threats of modern warfare, in particular those associated with the bomber. Although we will deal with the British effort in some detail, it is worth noting that in the USA radar systems were being developed, tested and manufactured from 1934 onwards. Indeed, when the Japanese attacked Pearl Harbour in 1941 there were already many different types in service with the US Army and Navy.

We must also be aware that a parallel technical discipline, now called Electronic Warfare (EW), was also needed. Initially this was aimed at jamming an enemy's radar using electronic countermeasures (ECM), or protecting one's own systems from jamming using electronic counter-countermeasures (ECCM) respectively. Much of this innovative work, along with corresponding radar, navigation aids and communications has been described elsewhere (see references 1, 2, and 3).

In the USA, Dr F.E. Terman at the Radio Research Laboratory, an offshoot of Harvard University and Dr (later Sir) Robert Cockburn at The Telecommunications Research Establishment at Swanage, UK were to lead teams of gifted individuals in this most challenging aspect of military radar operations. (Today EW is more sophisticated and covers many more aspects of military operations than the simple jamming, 'spoofing' or protection of radar systems.)

Before summarising what was in progress on the world scene, and the technical challenges which needed to be overcome, some basic operational requirements of radar systems need to be described.

The operational need

In the classic military situation, the early detection of potential threats is required in order to alert the defences; but at the engagement level, it is necessary to be able to track (and engage) individual targets. To meet these ideal and dual requirements, defences need the long-distance surveillance system — that is, early warning radar — and a tracking system for the final engagement.

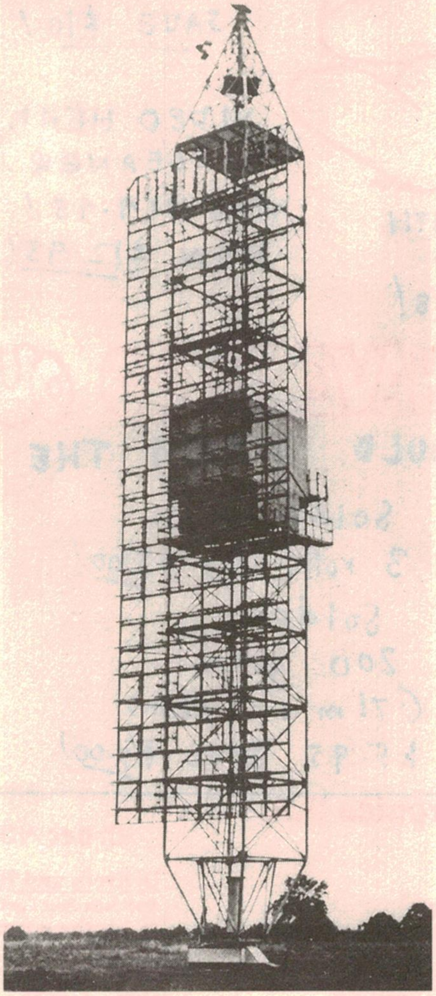

Fig.2.1: Germany's Wasserman used a rotating antenna some 40m in height. It was capable of detecting aircraft at a range of about 300km, including determining their range, height and bearing. (Photo courtesy GEC-Marconi)

Radar systems need to be carried on platforms, whether on land, sea or air. In the military situation the enemy are not naturally cooperative targets, and will attempt to deceive or evade the detecting radars to enhance their chances of survival.

Angles and range are needed to be able to fix the position of a target. For angular accuracy, narrow antenna beamwidths are desirable. The higher the frequency, the narrower the antenna beamwidth becomes for given antenna dimensions — incidentally also allowing for smaller antennas. Range is determined by measuring the time from transmitting a pulse to receiving its echo; a round trip of one microsecond corresponds to 150 metres.

For superior resolution, such as in mapping, short wavelengths are needed to 'draw' the map with sufficiently fine detail. Hence there was, and still is, a general move towards using high power pulses at microwave frequencies in radar systems and, where possible, using monostatic radar.

If target *speed* with respect to the transmitting source is required, the Doppler effect is generally used (where the measured change in reflected frequency is translated to radial speed with respect to the transmitter) and thus some form of continuous wave (CW) may be required. The advantage of combining pulses and CW for specific applications was recognised early, and nowadays pulse doppler radars are commonplace. And, because radar returns may be reflected from unwanted sources such as natural features, it is desirable to display moving targets alone using a Moving Target Indicator (MTI).

There are many variations on these simple themes. Skolnik (Ref.4) is recommended for those requiring more technical detail. Some of the various approaches adopted at the time in a

Fig.2.2: The Wurzburg gun laying and searchlight control radar operated at 560MHz and was very successful in targeting British bombers, at ranges up to about 35km — especially before electronic counter measures were used. (Photo courtesy GEC-Marconi)

number of countries, to meet these requirements will now be examined, together with descriptions of some of the resultant systems. Space does not allow for an exhaustive summary.

The world scene

In Germany Dr Rudolph Kühnold, Chief of the German Naval Research Division, had carried out advanced work with Echo Sounders but had realised their limitations for detecting aircraft. Accordingly, in about 1933, Kühnold developed a continuous wave radio detection system operating at 625MHz. Successful trials, using a prototype apparatus manufactured by his company, Gesellschaft für Electro-akustische und Mechanische Apparate (GEMA), were carried out in 1934 when a battleship was successfully detected at about 600m.

As elsewhere, the limitations of CW techniques were realised and GEMA produced a pulsed version which was effectively an elementary gun-laying radar. In 1936 sea and air trials were conducted using a modified GEMA system operating at 375MHz, the forerunner of the Seetakt used on the pocket battleships, entering service in 1938.

The success of this system in detecting aircraft at 30km led to the development of a further specification based on the GEMA set operating at 125MHz — later to be known as Freya, the successful German aircraft detection set. The story of German radar development is well told by Swords (Ref.5). Although not strictly a radar system, the Germans also developed a radio navigation aid called Knickebein by 1940. This used cross beams operating at 30MHz and allowed German bomber aircraft to drop bombs with a theoretical accuracy of 1km in any weather (Ref.1).

Without a high-power microwave source, German development effort was concentrated in the MF, VHF and UHF bands — until towards the end of the war, when a British Cavity Magnetron fell into their hands. Their Freya surveillance radar, using advanced vacuum tubes entered service in 1938, and could detect aircraft at about 120km, later 200km. It was also adopted by their Navy in modified form.

A later and much larger version, the Mammut, using electronic beam steering with an increased detection range of about 300km, was to be installed during 1942 as part of the German early warning system. A more modern style radar operating at 120-150MHz, the Wasserman (Fig.2.1) was used in conjunction with the Mammut and was able to determine aircraft height, range and bearing, becoming the outstanding early warning radar of the war.

Germany had the successful gun-laying and searchlight control Wurzburg in action by the end of 1940 (Fig.2.2). Its relatively short range of about 35km made it unsuitable for night-fighter control and a larger version, the Giant Wurzburg (Fig.2.3), also operating at 560MHz was introduced and used for the control of night fighters and anti-aircraft fire.

The Germans introduced airborne intercept (AI) radar to their night fighters, commencing with the Lichtenstein (operating at 490MHz) which was followed by the SN2 (operating at 90MHz). These were later supplemented by systems which could track the navigational aids such as H2S, carried by the allied bombers.

Indeed at the beginning of World War II, it could be said that some aspects of German radar development were far ahead of other countries. That it did not remain so was due to a re-allocation of technical effort within the Reich, as the German High Command thought that the war would be well won before the systems could be brought into service.

In Japan, Professor Okabe at the University of Osaka was experimenting with systems in the 40-80MHz band. During 1936, possibly following discussions with Professor Yagi, he proposed a system of Doppler radar, by which aircraft could be detected and velocities measured, later successfully demonstrating prototype systems.

Most of these systems were useful for simple surveillance tasks, but lacked the ability to track hostile platforms with sufficient precision to enter engagements. Less well known is Okabe's work on magnetrons, during a 20 year period which finally resulted in an X-band (3cm) pulse device capable of producing over 20kW.

Although, in 1942, the Japanese Navy received their first centimetric pulse radars (Mark II, Model 1), radars operating at about 150MHz (Mark II, Model 4) were widely fitted to the smaller vessels. Details of Japanese radars may be found elsewhere (Ref.6).

The Japanese, then conscious of the necessity of defending their homeland against Allied bombers, set up an Air Defence System initially based on rudimentary bistatic systems. The Army used both monostatic and bistatic radars. The Japanese effort was boosted by access to captured British and American sets, and also technical support from the Germans. Several versions of gun-laying and

Short History of Early Radar

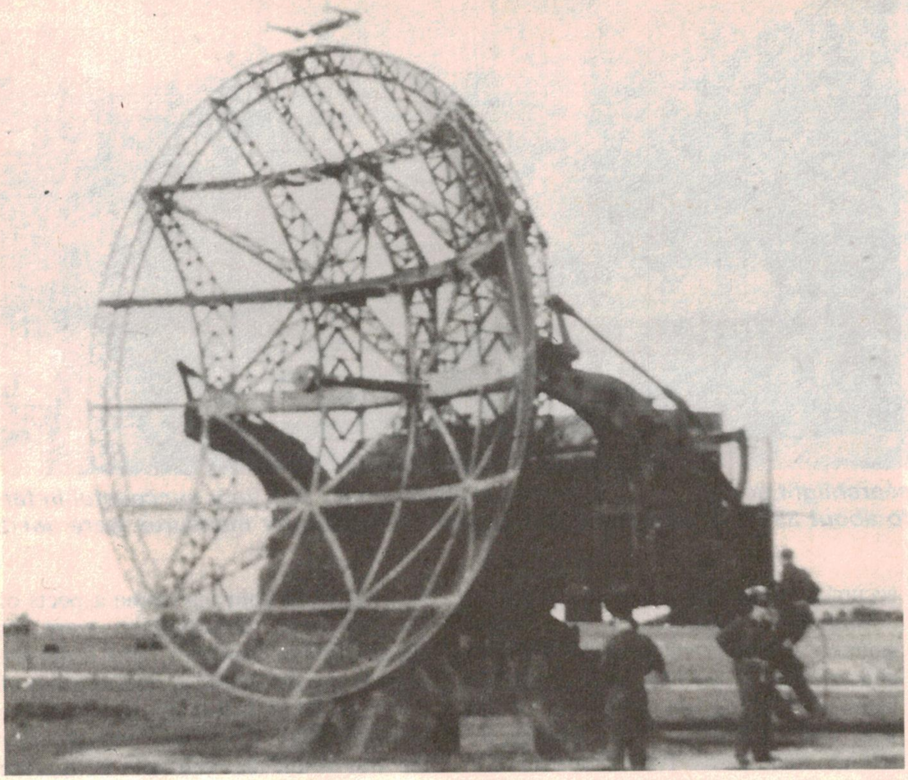

Fig.2.3: The Giant Wurzburg was essentially a Wurzburg gun-laying radar with an enlarged dish of about 6m diameter. This radar, with an operational range of about 70km, was primarily used for the control of night fighters. (Photo courtesy GEC-Marconi)

searchlight control radars produced were essentially modified copies of captured Allied equipment; these were the largely unsuccessful Tachi-1 and Tachi-2 systems operating at 200MHz, and later the more successful precision Tachi-4 and Tachi-31 versions.

A Tachi-3, based on the British MkII gun-laying radar operating at about 75MHz became well known. Also well known were the Tachi-6 and Tachi-7, early warning sets operating at about 70 and 100MHz respectively: both were capable of detecting aircraft at ranges of about 300km. By the end of the war the Japanese were reasonably well versed in Electronic Warfare.

The Soviets, after abandoning much of their research into infrared and sound detection methods, concentrated their very early efforts in producing bistatic CW radio detection systems and into the development of cavity magnetrons and klystrons. Prototypes of their first system, known as RAPID, were tested in 1934 and were successful in detecting aircraft at a range of about 70km. These were to operate in the VHF band and were to be used for simple surveillance across some of their frontiers.

Recognising that such radio detection systems were quite inappropriate for gun-laying required by the Russian artillery, research was instigated which eventually resulted in a simple pulse radar in 1936. This operated at about 750MHz and was capable of detecting aircraft reliably at 15km.

By 1939 the Soviets, despite purges of their laboratory staff, had developed a mobile pulse system, known as REDUT, able to detect aircraft at the much increased range of 150km. However although these systems were found useful in fighter control, they were unsuitable for gun-laying. A number of developmental models were produced with limited success. Nevertheless, working in isolation, monostatic pulse radar systems such as the SON-2A and RUBIN monostatic systems were ready for service by 1942 and 1943 respectively.

By this time Russia had received similar equipment from Britain and the USA, which assisted them in refining their own designs. Like Germany, Russia was handicapped by bureaucratic interference in its research activities and as a result progress was unnecessarily stifled at critical points in time.

France too had its experimenters in this new science. Pierre David had proposed a bistatic system operating at 75MHz in 1928, this only being successfully tested in 1934. Following these tests a bistatic system was installed across much of France by 1939.

Further work, with which the name of Maurice Ponte and commercial organisations were associated, was carried out in the non-military field. One well known result of this was the fitment of a CW 1875MHz Collision Avoidance radar on *SS Normandie* in 1935, by Société Française Radioélectrique (SFR).

By 1938, and with the support of Pierre David, prototype decimetric systems using split-anode magnetrons were under test. It was one of these magnetrons, which used an oxide-coated cathode, which was to assist Randall and Boot in the development of the much more successful *cavity magnetron.* Surprisingly, research and development activities continued after the fall of France for about two years when, after the invasion of unoccupied France, all data and equipment were destroyed before they fell into German hands.

Despite brilliant research by a few gifted individuals such as Professor Ugo Tibero, Italian radar development was hampered by lack of funds and official interest. By the time the Italian High Command had realised the benefits of radar, after their heavy Naval defeat at the Battle of Matapan in March 1941 by British radar-controlled gunfire, it was too late to catch up. This is all the more surprising since Marconi had demonstrated the principles of Doppler radar in 1935.

Some member countries of the British Commonwealth were made aware of the British research and activities in radar. Canada, for instance, played a major part in the production of the British designed GL3C gun-laying radar. On the other side of the world, The Department of Radio Physics of The Commonwealth Science and Research Organisation (CSIRO) in Australia was soon to start developing and building experimental radar systems, and some of these were soon to find use against Japanese aircraft (Ref.7).

Outstanding developments

Let us now look at some of the other developments in radar systems which took place in the leadup to, and during, World War II — for it was in this work that laid the foundations of the systems still used today. Remember that the main preoccupation of the designers and the military of the time was towards the detection and destruction of hostile aircraft and the navigation of their own; soon it was to be adapted to naval mat-

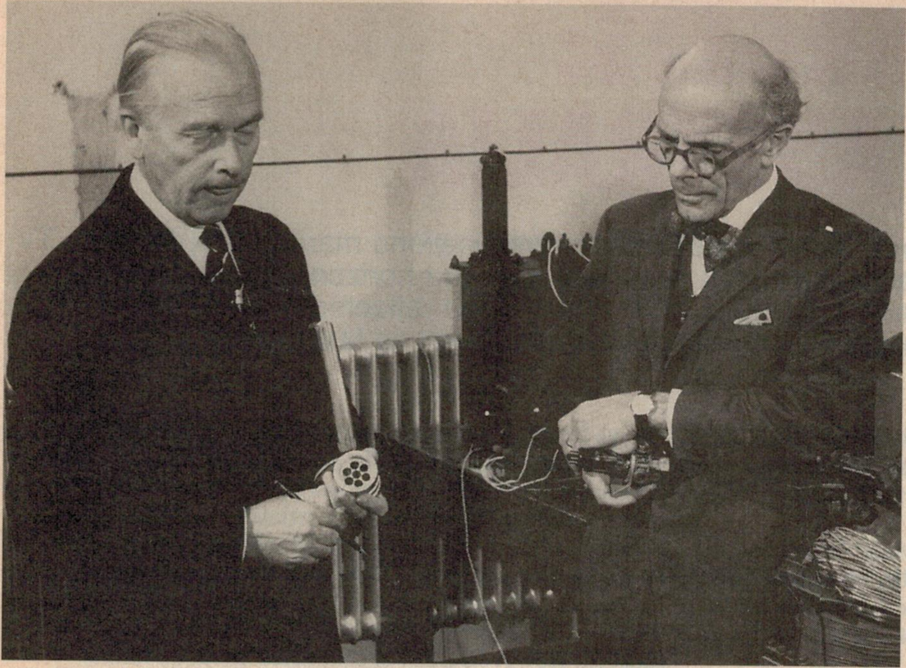

Fig.2.4: Professor J.T. Randall and A.H. Boot with one of their early magnetrons in early 1940. They were aided in this development of the cavity magnetron by comparable French research on split-anode magnetrons using oxide-coated cathodes. (Photo courtesy of GEC-Marconi)

ters, gun-laying and the detection of submarines on the surface.

Four major developments opened up the field of radar. Firstly there was the invention of the *duplexer* in 1936, by Robert Page at the US Naval Research Laboratories. This allowed the common use of an antenna for both transmitting and receiving purposes, of special importance in pulse type radar. (The duplexer may be described simply as a two-way switch which prevents transmitted power from entering, and so overloading the delicate receiver circuits.)

The second major breakthrough was the use of the cathode ray tube to map the information received from an associated rotating antenna beam. This was known as the *Plan Position Indicator* or 'PPI' — still used today. Associated with this was the Moving Target Indicator (MTI), which allowed movement, not static information, to be observed.

The third, and possibly the most important development, was that of the high-power cavity magnetron by Randall and Boot, at Birmingham University in 1940. For the first time this provided a reliable high-power microwave source — a discovery which was immediately shared by the British with the USA. With outputs of 500kW at 3GHz (S-band) and 100kW at 10GHz (X-band), both the British and the Americans then had a tool which resulted in their taking an undisputed lead in the wartime development of radar technology. (It is interesting to note that the Russians and Japanese had also, and quite independently, developed cavity magnetrons.)

Finally, *automatic tracking* systems were developed. Once locked on to a target a single-antenna (or co-located) system would thus continue to track the target, by day or night, so long as the target remained in radar range.

Because the initial impetus for the development of military radar was to combat the very real threats to civilian populations posed by the then-emerging modern aircraft, any general history of radar such as this, must dwell upon the air war. Similar, and equally spectacular, developments were to take place in the applications of this new science to the war at sea (Ref.8) and on land.

Ships were to be fitted with radar, not just for navigation and collision avoidance, but to fight their foes on the sea or in the air. The use of sonar with ship-borne radar complemented airborne (ASV) radar in defeating the U-boat menace at sea. It must be said that radar was only part of integrated military systems where improved communications, the location of potential adversaries using radio direction finding techniques, intelligence and so on were all to play an important part.

In the next article, British and US progress in radar will be considered. This progress was to go a long way towards enabling the Allies to win the air, ground and naval wars in Europe, combined operations in the Pacific and the Battle of the Atlantic.❖

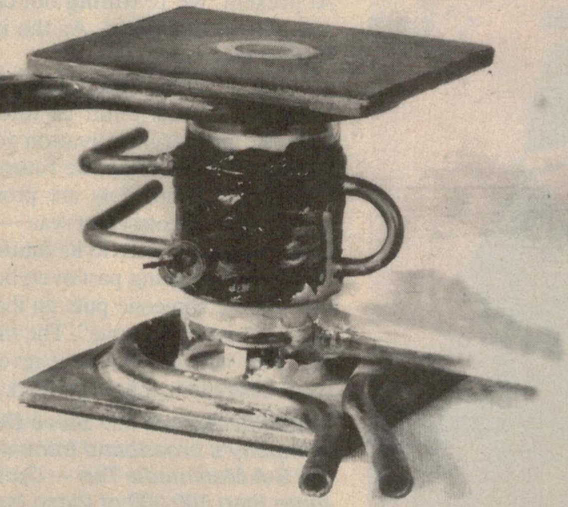

Fig.2.5: One of the early magnetrons developed by Randall and Boot at Birmingham University. Within a few months, the RF output of such prototype valves had jumped from hundreds to many thousands of watts. (Photo courtesy GEC-Marconi)

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MOVING TARGETS: PAY TV IN AUSTRALIA

When Scientific-Atlanta first arrived in the Australian communications market in 1982, Pay TV, broadband technology and interactive services were well over the horizon. Things are certainly quite different now, as the company's Australian MD Steve Dean reflected recently when Barrie Smith talked with him to get an update on recent developments in this fast moving area...

by BARRIE SMITH

Steve Dean has seen it all — right from 1982, when the Australian Government asked the Canadian Government to 'float' its ANIC-2 satellite across the Pacific for early field trials of satellite technology.

During these trials, Scientific-Atlanta provided 'a large number' of antennas, arrays of which were installed in remote parts of Australia. Test equipment connected to these antennas evaluated the behaviour of Ku-band signals in Australia with an eye to future DBS deployment.

Today, the company employs 20 people in Australia, serving three distinct industries: defence, involving mainly test instruments for antenna design; satellite networks and the sale of earth stations; and broadband communications — at present the company's biggest revenue stream.

Watching brief

If you really want to know what is happening in the communications industry, Steve Dean is obviously one of the best people to ask. His knowledge of the industry is broad, while his comments are often succinct.

In Dean's view, S-A and General Instruments are "probably the only fully vertically integrated companies in Pay TV". Both provide broadband equipment that supports a broadcast signal from transmission through to home reception.

Scientific-Atlanta MD Steve Dean pictured with some of his company's broadband transmission products. In his hand is the S-A Multimedia Tap — Optus Vision has placed orders for more than 500,000 of these taps to date.

Says Dean: "From a manufacturer's point of view, we have to watch what's happening in the programming world — a potential operator needs the right programming to succeed. They also need financing, franchises and a 'friendly' regulatory environment before they can build a new network. In a new market like Australia, you must watch these indicators."

Early on, pioneering Pay TV operator Australis grabbed a clutch of MDS licences and seemed to have the right stuff to succeed. However, Dean is concerned about its future:

"Australis spent a lot of money for its MDS and satellite licences. This investment will be difficult to recover. When we look at these technologies, they're not the ones that will necessarily compete against cable in the future. Pay TV's future lies with interactive services. Cable is a more cost-effective technology for these new services, so Australis will find it difficult to compete against cable operators like Optus Vision and Foxtel."

So how was 1995?

When I asked him for his impressions of developments in 1995, Dean replied "For us it was a record year of business." The same can't be said for others in the Pay TV industry. Reports from the field indicate that Telstra, Australia's incumbent telco organisation, has problems with its new cable network. Inexperienced crews may have damaged coax cable, resulting in serious reverse noise ingress. If these reports are accurate, Dean agrees the problem would be expensive to repair.

"You can measure a cable electrically and get a working signal. However, measure the impedance, and you'll find reflections all through it. This sort of interference makes it useless for two-way interactive services."

"To be fair, you need to put what's happening here in perspective. Pay TV is on a steep learning curve in Australia. At present, we're rolling out cable networks faster than anyone else in the world. As the incumbent, Telstra has a lot to lose in this race."

"Like a lot of other telcos, Telstra believes that to stay in business, it must build an information superhighway. Video isn't the primary motivation for the current cable build. It's very concerned about the future, beyond ISDN."

Telstra's competitors are promising telephony services over cable, but its greatest fear was — and still is — the danger broadband cable represents to its future business. With a high capacity, two-way pipe going past everybody's home, it's only a matter of time before someone puts up their hand and says "I want to run my business from home". The first operator to offer say 2Mb/s to the door will get this new revenue stream. Once Telstra loses these customers, it has too work twice as hard to win them back.

As Dean points out: "Telstra saw the danger two years ago, but knew that expanded data services were still several years away. To help recoup the cost of a cable build, it needed more immediate revenue streams, and chose to build a CATV system using traditional technology."

However, Pay TV is a very different world. Telstra soon realised that its network needed the right programming to succeed; it had no experience producing programming, and so looked for a broadcasting partner. After some vague tilts at becoming a common carrier, selling channels off one by one, Telstra signed a partnership with Rupert Murdoch's News Corporation which created Foxtel. After its announcement, there was public concern at the partnership, and there are still pockets of resistance within Telstra itself.

In Dean's view, "Telstra misunderstood Murdoch's ability to lock in programming. Because he owns the Fox network, it actually precludes him from negotiating deals with some of the other programming houses. He's their competitor!"

In late 1995, Foxtel's attempts to merge with Australis were thwarted by the anti-monopoly authorities. Foxtel then lost the battle to establish Super League. Popular sports programming is considered vital for the success of Pay TV in Australia; the failure of Super League leaves Foxtel with an inferior sports line-up compared to its only major competitor, Optus Vision. As if this were not enough, Australis was forced to cut costs by reducing staff levels as insolvency loomed.

Dean says Optus has managed to strike up programming deals cheaper than Foxtel. In his opinion it has "a good mix of programming that includes the right sports, popular movies, 'family entertainment' and news."

So are things settling down now?

Hardly, says Dean: "They're still boiling. Things will remain volatile until both operators have completed the bulk of their network build."

While Optus is building its network at a very rapid rate, Telstra remains ahead in terms of the number of homes passed. In Dean's view there's another factor that adds to the uncertainty; he says the current subscriber take-up of Pay TV is lower than he would have expected. Australians have a history as early adopters of new technology, but he's uncertain that Pay TV is following this pattern: "For more than a year, there's been a lot of confusion in the market. With three operators to choose from, I think people are waiting to see who's offering what before they commit their dollars."

NZ, South Pacific

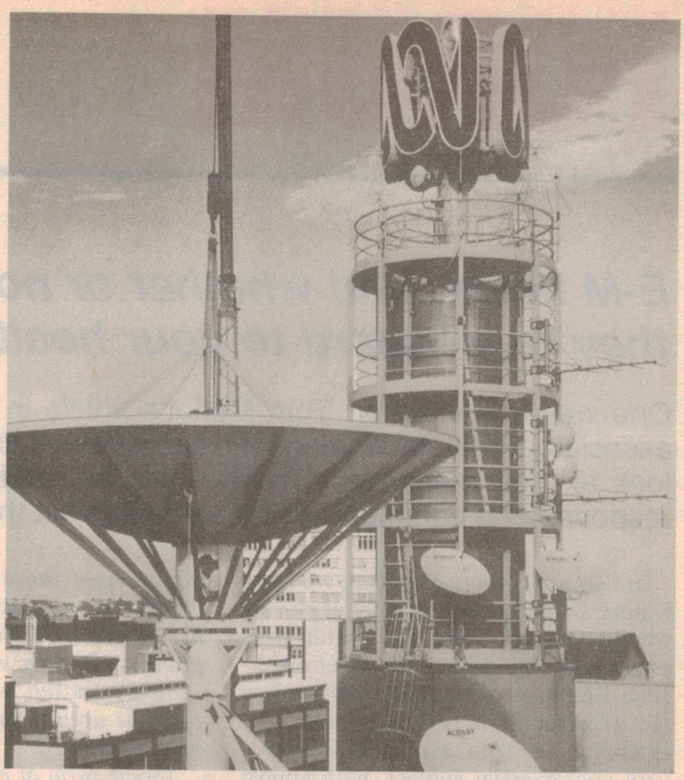
The New Zealand Pay TV scene Dean finds even more confusing. He predicts increased incursions by US interests. Like its counterpart in Australia, he views NZ Telecom with some sympathy.

"Telecom NZ is still running a fibre to the kerb pilot, using S-A hardware, but for the immediate future it's chosen a cable system."

According to Dean there's no significant market elsewhere in the South Pacific. The island nations have population centres and revenue abilities barely larger than a typical Australian metro suburb. "There are limited satellite feeds over most of them. For maximum programming, they'd need large earth station installations. We'd love to sell these, but the population base is too small to recover the expense."

And the ABC?

The ABC recently began a nine earth station upgrade to its domestic interchange network using S-A equipment. It also began a trial using S-A's MPEG2 based PowerVu system. The latter makes the ABC the country's first operator to use digital compression internally.There was some initial resistance from the broadcast industry, as Dean recounts:



The ABC is currently upgrading its interchange network with nine Scientific-Atlanta earth stations. This antenna is at the ABC's Ultimo building in Sydney.

"When the broadcasters first looked at MPEG signals, the artefacts they saw caused confusion. They didn't actually show up as a 'noisy' signal, but the engineers were not used to seeing them in a transmission."

"From a purist engineering point of view they said 'Look at all those artefacts', and were critical of its quality. They ignored the fact that current analog pictures also contain artefacts, which are common and accepted as normal."

"Any analog signal has noise in it, which people see in the home. The MPEG signal, with it own type of artefacts, actually looks much better."

The nine ABC earth stations range from 6-9 metres, depending on their location in Australia. Dean believes the control system for them is probably one of the world's most advanced. S-A took its standard products for controlling multiple earth stations and wrote additional software to meet the ABC's requirements. Normally, earth station controllers, which are software devices, control power levels, monitor redundancy and reposition the earth station itself to maintain alignment with the satellite overhead. The ABC wanted to dynamically switch its video signals.

Dean: "From one terminal they can control all the dishes around the country, switch in a feed from here, another feed from there — something that involved a lot of people, in the past."

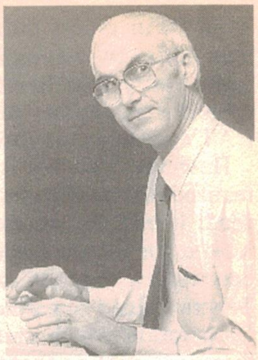
The new boys...

While Steve Dean had yet to talk to Sen Richard Alston, the new Liberal Communications Minister, when I spoke with him, he confirmed that "in opposition one of the topics very close to his heart was Pay TV. So if anyone understands how Pay TV ought to work, he does."

But considering the investments at stake and the delicacy of the business itself, Dean expects no dramatic change to the status quo in the short term. ❖

FORUM

Conducted by Jim Rowe



E-M fields, and whether or not they're a hazard to your health...

One way and another, Tom Moffat's article in the February issue on the possible health risks associated with electromagnetic fields seems to have stirred up a few people, and this month we look at their responses. There's also an 'addendum' from Tom himself, and a rather cutting response to a comment on the same subject that I made myself, in last September's editorial.

In February, you may recall, we ran a feature article by Tom Moffat exploring whether or not there are health risks associated with man-made electromagnetic fields — of the type surrounding the antenna of a cellular phone, for example. As Tom explained this is a very controversial subject, with almost as many 'authorities' willing to argue that these fields are quite harmless as there are others convinced that they're a serious risk. At the same time, the big mobile telecommunications carriers and equipment makers seem to be trying to 'bury' the subject, in the hope that we'll forget that it was ever raised...

Not surprisingly, then, Tom's article has produced a few responses. I think you'll find them interesting, and you may also want to consider another letter which takes me very much to task for comments I made in the editorial column last September.

But before we present these contributions from readers, I'd like to present a follow-up message that came from Tom Moffat himself, via e-mail. It provides an effective update to his February article, taken from one of the daily newspapers in the area where Tom is currently living. He introduces it thus:

Jim, the following item appeared in the May 17 edition of the 'Seattle Post-Intelligencer'. Certain readers might find it interesting...

CELL PHONES ARE FOUND TO DISTURB PACEMAKERS

Those relying on heart devices are cautioned.

Some cellular telephones — particularly the newer, digital variety — can interfere with heart pacemakers, an industry-sponsored study indicates. The interference can cause the heart to speed up, slow down, or perhaps even stop.

Researchers meeting in Seattle yesterday advised those who are completely dependent on pacemakers for normal heart rhythms to avoid using digital cell phones. If they must be used, care should be taken to avoid placing them over the area where the pacemaker has been implanted.

"Some form of electromagnetic interference was seen in more than half the patients we tested," said Dr David Hayes, director of pacemaker services at the Mayo Clinic in Rochester, Minn.

A spokesman for one of the telecommunications companies that helped fund Hayes' study through a blind trust and independent consortium called Wireless Technology Research, called the study flawed. "We had some problems with the methodology," said Ken Woo, spokesman for ATT wireless in Seattle.

Hayes and his colleagues studied 975 people with different kinds of implanted cardiac pacemakers and had them use a variety of cell phones. The researchers also had patients hold the phones in various positions, including directly over the chest where the pacemaker was implanted.

In general, Hayes' group found that people who had older pacemakers and used digital cell phones placed on their chests when transmitting a signal were most at risk for electromagnetic interference of their pacemakers. The older and more common analog cell phones rarely caused interference with the pacemakers.

"There was a significant difference in the incidence of EMI (electromagnetic interference) between digital and analog phones", Hayes said.

Hayes presented his findings yesterday at a meeting of the North American Society of Pacing and Electrophysiology at the Washington State Convention and Trade Centre.

The electromagnetic interference was never allowed to persist long enough in the tests to cause any health problems, Hayes added. The matter is still being studied, and a full report will be released in July, he said.

The Cellular Telecommunications Industry Association has issued a news release in response to Hayes' findings, noting that the Food and Drug Administration did not believe the study required any change in policy. The FDA already advises people to avoid placing cell phones in close proximity to pacemakers.

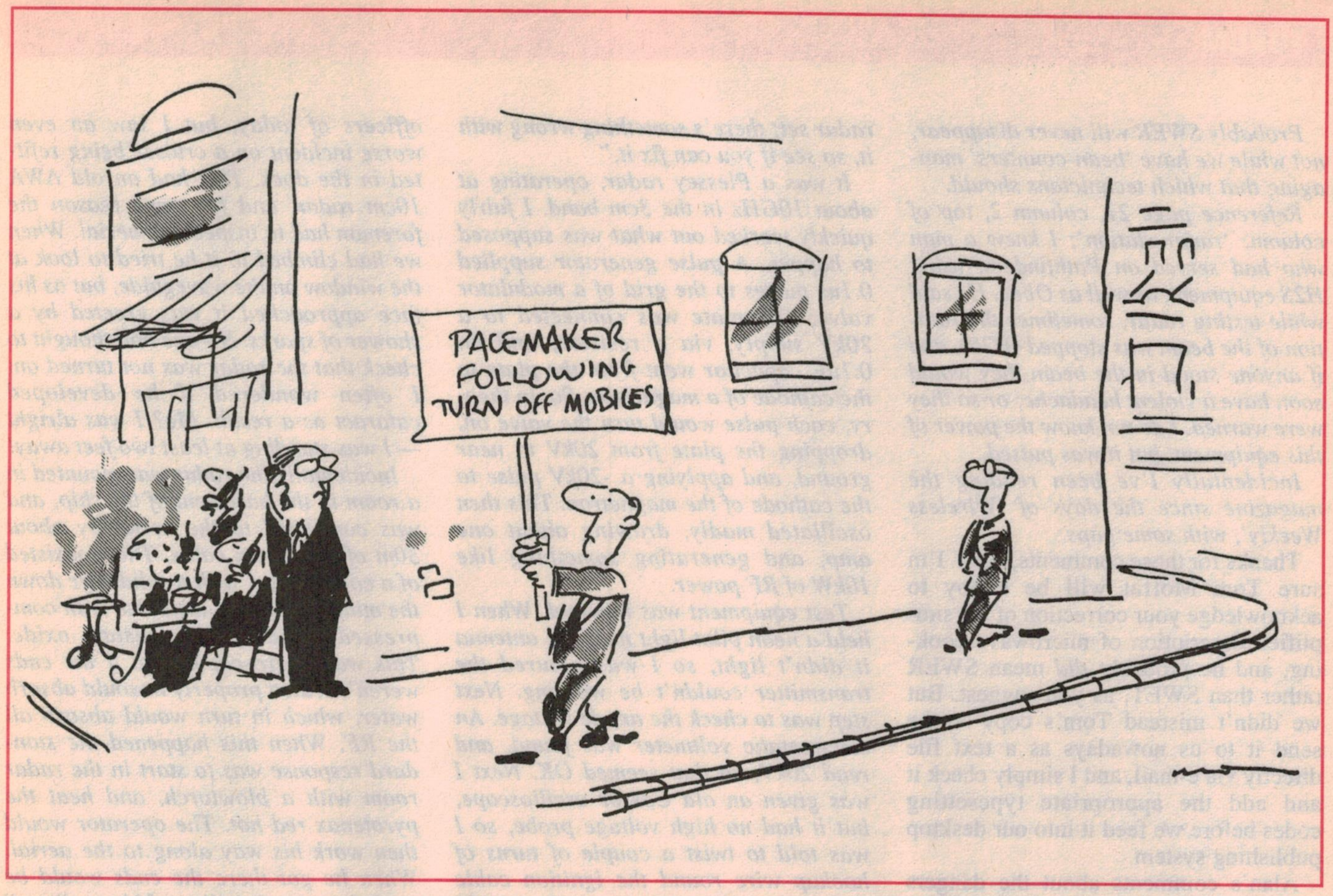
Woo of AT&T Wireless noted that many devices besides cell phones put out radio waves in the same frequency range that could theoretically interfere with pacemakers.

"You get the same thing from police and fire radios, garage openers, and even microwave ovens," he said. "Why we keep singling out cellular phones, I don't know."

Arthur Guy, a University of Washington professor of bioengineering and an expert on the medical application of electromagnetic devices, said cell phones have been singled out because of the "sheer numbers".

"If there was a health effect from cell phones, because of their popularity, it would be a major public health concern," Guy said. So far, he said, there has been equivocal evidence for any serious health problem. Guy is on the board of directors for the Wireless Technology Research fund.

The fund was established as a blind trust by the industry to sponsor independent studies on the health effects of cell phones. It was established, Guy and Woo said, after a Florida man filed a lawsuit claiming his wife's brain cancer was caused by use of a cell phone. The lawsuit, which got widespread media



attention, was dismissed by a judge who ruled that the plaintiffs had presented no evidence to back up the claim.

Hayes' study was the largest clinical trial to date of the potential effect of cell phones on pacemakers. Each year more than 130,000 people in the United States have a pacemaker implanted to regulate their heartbeats. At least 16 million people use cellular phones.

The study group will issue recommendations based on their complete findings in July. The FDA will then evaluate the group's findings to determine if new guidelines are needed.

Well, there you are. More food for thought, don't you think? Thanks to Tom Moffat for sending that item for our consideration. Perhaps he'll try to get a copy of the full report, when it appears, in case it provides more interesting material.

I don't know about you, but I found it particularly ironic that the research study concerned had been financed by the American CTIA, via a 'blind trust'. It seems a bit like the tobacco industry financing a study on the health effects of smoking, only to come up with embarrassing evidence that their products cause cancer!

Mind you, in this case the evidence that cellular phones may have an adverse effect on heart pacemakers is not quite the same as saying that they might cause brain cancer, etc. In one case we're talking about direct interaction between an electromagnetic field and living tissue, while in the other we're looking at what may be a electromagnetic incompatibility between two items of man-made equipment: a cellular phone and a cardiac pacemaker. It's really a different kind of problem, even though it might still pose a serious health risk...

From the inside?

Now let's look at some of the responses to Tom's February article, from other readers. The first comes from Mr Alan Brooks, of North Mackay in Queensland. Mr Brooks makes a couple of critical comments, which he describes as 'a little nit-picking', and also adds a couple of interesting asides:

Reference Electronics Australia, February 1996, article 'Cancer and E-M Fields: Any Truth in It?' page 18, first column, about 20% of the way down:

'...microwave oven... Meat cooks from the inside...' This could be better stated. When I read this many years ago, I did not apply any thought to it, and until it was demonstrated to me in practical terms, I thought this meant that food in a microwave cooked from the centre. Whereas in fact the microwaves penetrate only a short distance, until their energy is absorbed by conductive material. The better way of expressing it may be that the food cooks from somewhere below the surface, the distance inside depending on circumstances.

Reference again page 18, second column, foot of column:

'...magnetic fields affect... someone wearing a cardiac pacemaker.' I knew a man, born about the turn of the century and now gone to a better place, who thought nothing of 'mild' shocks from contacting 240V while working on live apparatus. When he was later fitted with a cardiac pacemaker, he wondered if his careless attitude had contributed to the need for the pacemaker.

Reference page 19, first column, about 50% of the way down the column: 'SWET (single-wire-earth-return) power lines'. I believe this is a misreading of Tom's copy; it should be SWER. By the way, I think they run at about 17kV, and some consumers pour some water around the earth mat at their end of the service when the lights appear dim, in dry weather.

Probably SWER will never disappear, not while we have 'bean-counters' managing that which technicians should.

Reference page 21, column 2, top of column: 'radar station'; I knew a man who had served on Pathfinders, using H2S equipment, as well as Oboe. He said while testing radar, sometimes the rotation of the beam was stopped (H2S), and if anyone stood in the beam they would soon have a violent headache; or so they were warned. I do not know the power of this equipment, but it was pulsed.

Incidentally I've been reading the magazine since the days of 'Wireless Weekly', with some gaps.

Thanks for those comments, Alan. I'm sure Tom Moffat will be happy to acknowledge your correction of his simplified description of microwave cooking, and he probably *did* mean SWER rather than SWET, as you suggest. But we didn't misread Tom's copy — he send it to us nowadays as a text file directly via e-mail, and I simply check it and add the appropriate typesetting codes before we feed it into our desktop publishing system.

Alan's comments about the dangers associated with the high intensity fields from a radar antenna are interesting, and as it happens they lead us quite naturally into the next contribution.

'That reminds me...'

Another interesting response to Tom's article came from Roger Riordan, the founder and MD of Melbourne firm Cybec — responsible for the highly regarded PC virus protection program VET. (We use VET here in the *EA* office, and it's one we can highly recommend.) Here's what Roger has to say:

The discussion on the dangers of pulsed radiation in Tom Moffat's article 'Cancer and EM Fields: Any Truth in it?' reminded me of my first serious encounter with practical electronics. At the end of 1952, after completing second year Electrical Engineering at Melbourne University, I went to the HMA Naval Dockyards at Williamstown (now run by Transfield) for the then obligatory work experience.

At that stage I had had no official introduction to electronics at all; all my lectures had all been in the basic sciences, but I was allocated to the Electronics shop. After being introduced I was taken to meet a metal box with a parabolic antenna, sitting on a bracket bolted to the wall of the hut. "This is a radar set; there's something wrong with it, so see if you can fix it."

It was a Plessey radar, operating at about 10GHz in the 3cm band. I fairly quickly worked out what was supposed to happen. A pulse generator supplied 0.1us pulses to the grid of a modulator valve. The plate was connected to a 20kV supply, via a resistor, and an 0.1uF capacitor went from the plate to the cathode of a magnetron. So, in theory, each pulse would turn the valve on, dropping the plate from 20kV to near ground, and applying a -20kV pulse to the cathode of the magnetron. This then oscillated madly, drawing about one amp, and generating something like 10kW of RF power.

Test equipment was minimal. When I held a neon pilot light near the antenna it didn't light, so I was assured the transmitter couldn't be working. Next step was to check the anode voltage. An electrostatic voltmeter was found, and read 20kV, so that seemed OK. Next I was given an old Cossor oscilloscope, but it had no high voltage probe, so I was told to twist a couple of turns of hookup wire round the ignition cable connecting the voltmeter to the anode, and connect the oscilloscope to that.

I could see pulses OK, but had no idea of the calibration of the 'voltage divider', so couldn't check the magnitude. I gradually worked through the circuit, and eventually established that the pulse generator was generating a healthy voltage, but it was connected to the grid of the driver valve via a relay, and the pulse coming out was much smaller than the one going in.

So I opened the relay, and found the armature was not seated properly, so the contacts were misaligned. I sat it down correctly, checked that the contacts were now closing, and switched the radar on again. This time there was no mistaking that there was a pulse on the anode — when I went to check it with the oscilloscope, a spark jumped to the lead when it was about a centimetre from my pickup loop, and the spot disappeared for several minutes.

I had done it! The radar was now working, and I spent hours running it in the lab. I could watch boats in the bay, and even with the wooden lab doors closed I could get echoes from the Dandenongs 25 miles away. The radar was mounted at about eye height, but no-one worried about it running all day.

No doubt this would horrify the safety officers of today, but I saw an even worse incident on a cruiser being refitted in the dock. This had an old AWA 10cm radar, and for some reason the foreman had to inspect the aerial. When we had climbed to it he tried to look at the window on the waveguide, but as his face approached it was greeted by a shower of sparks. No-one had thought to check that the radar was not turned on. I often wondered if he developed cataract as a result. Me? I was alright — I was standing at least two feet away!

Incidentally the radar was mounted in a room in the basement of the ship, and was connected to the aerial by about 30m of pyrotenax cable. This consisted of a copper pipe, with a solid wire down the middle, and was insulated with compressed powdered magnesium oxide. This was hygroscopic, and if the ends weren't sealed properly it would absorb water, which in turn would absorb all the RF. When this happened the standard response was to start in the radar room with a blowtorch, and heat the pyrotenax red hot. The operator would then work his way along to the aerial. When he got there the ends would be sealed again, and all would be well until the next time...

This was a wartime unit, and I think the 1.0us pulses were generated by a rotating toothed wheel, which acted as a spark gap to periodically discharge a length of delay line charged to a high voltage.

At the end of the vacation I felt I had acquitted myself honorably, but I never did find out if I had fixed a real fault, or if the relay had been tampered with just to give me something to do.

Hmmm — thanks for those reminiscences, Roger. As you say, today's safety officers would no doubt be horrified by the things that were regarded as commonplace in 'the good old days'. And probably rightly so, because many of the things that were done did represent a serious health risk, if only we had known...

Similar situation

I remember a vaguely similar situation myself, in fact. In 1958-59, just before I joined the magazine, I worked in the School of Electrical Engineering at the Uni of NSW. I remember that the School had acquired an old radio transmitter from somewhere, with an output of about 3kW, if I recall correctly. It was rigged up with all of its RF output applied to a couple of large metal plates, to allow demonstrations of dielectric

heating. The plates were a few inches apart, and the demonstrations consisted of sprinkling half a packet of raw peanuts on the lower plate, and then turning on the transmitter for a few minutes. The peanuts would then be nicely cooked — but thinking back, I wonder how many of us received quite a dose of E-M radiation at the same time!

'Contributes nothing...'

And now to our final contribution this month, which is rather more critical than the others. As I mentioned earlier this one is not a response to Tom Moffat's article, but rather to my editorial comments in the September issue last year — and the reference to them by Ms Betty Venables, whose letter we published in the April issue.

You may recall that my September leader was prompted by a *Four Corners* programme on ABC-TV, exploring the possible health risks associated with electromagnetic fields. And I was basically reacting to comments in the show from some of the 'experts', who at least gave the impression that they took the position that because the E-M field strengths produced by the equipment concerned were lower than 'accepted standards for safety', there wasn't a demonstrated safety risk...

Anyway, this new letter comes from Mr David Samuels, of the Australian Radiation Laboratory in Yallambie, Victoria. And Mr Samuels, who is apparently Assistant Science Information Officer at the ARL (part of the Commonwealth Department of Human Services and Health), obviously doesn't think much of the comments by either Ms Venables or myself:

Betty Venables' letter to EA (April 1996) criticises regulators for making 'trite remarks' about possible health hazards from electromagnetic fields (EMF). Ms Venables claims that anecdotal evidence often correlates with scientific research and that the authorities' comment, that these health effects are 'not proven', is of no comfort.

Anecdotal evidence has no part in the setting of guidelines on exposure to EMF or any other health hazard. Authorities must base regulations on the best scientific evidence available at the time. The current guidelines on exposure to EMF represent an international consensus opinion from individual experts representing neither their countries of origin nor their parent institution. Ms Venables' accusation that this comment is glib — 'not proven' — is the best conclusion that can be made from many years of scientific research in this field. Furthermore her reference to one opinion, such as William Adey, for being critical of regulators, cannot carry sway.

Ms Venables supports the EA editorial (September 1995) in which you close by saying "It's quite conceivable that investigation could show that current 'safe levels' of exposure to E-M radiation are in reality too high..." This demonstrates a lack of understanding of what the Australian EMF Standards are about. They are not safety levels, they are in fact recommended exposure limits. Because our knowledge of the health effects from EMF exposure is incomplete, the exposure limits do not guarantee safety. So the above statement will always be true, and contributes nothing towards the debate.

The setting of regulations for EMF exposure where the hazard — if any — is small, requires a sound knowledge of epidemiology and a conservative approach. Ms Venables' letter and your editorial do not meet these requirements.

So there! We ignorant plebs should pull our heads in, and leave it all to the experts like Mr Samuels and his colleagues — people with a sound knowledge of epidemiology, who know not to confuse a 'recommended exposure limit' with a 'safe level of exposure'. Without such knowledge, we presumably have no right to even comment on these topics.

Well, Mr Samuels, I take your point that the official guidelines on recommended EMF exposure limits must be based on the consensus of scientific opinion, rather than on 'anecdotal evidence'. Fair enough. However it's also true, is it not, that the consensus of scientific opinion is a dynamic beast, which constantly changes in the light of additional evidence and upgraded scientific knowledge?

I would also suggest that the additional scientific evidence and upgraded knowledge often comes about because one or two scientists *are* prepared to at least consider 'anecdotal evidence' with an open mind, and are prompted to design and carry out new investigations. But I suppose you'd regard this comment as again 'stating the obvious', and accordingly 'contributing nothing towards the debate'...

To be honest, while I think I see where you're coming from, I'm not in the least sorry about having made the comments I did. To me, the fact remains that while experts like you and your colleagues at the ARL may know exactly what is meant by 'recommended exposure limits', and may also be well aware that these limits may well be changed in the light of further scientific knowledge, it's all too easy for you to give the rest of us the wrong impression.

For example in the *Four Corners* program that prompted my original comments, some of the experts concerned did give a clear impression (quite possibly unintended) that they regarded the current recommended exposure limits as quite safe. They also seemed to be dismissing out of hand the anecdotal evidence offered in the program, in a rather cavalier fashion — which didn't come over at all well, considering the nasty health problems suffered by some of the people who had been subjected to electromagnetic fields.

In short, whether they intended to or not, these particular experts managed to give the impression that they were rather complacent about the whole business. And it was this that I was really objecting to, because to my mind complacency just isn't scientific.

So in drawing attention to the fact that further knowledge could well result in a tightening of recommended exposure limits (or what I incorrectly termed 'safe levels of exposure'), I might well have been 'stating the obvious' from your point of view — but I still believe it needed to be said again.

As to whether people like Ms Venables and myself have a right to express our concerns on subjects like these, that's surely a moot point. As huge numbers of ordinary people are now holding small UHF transceivers right next to their brains for many minutes each day, I think any possibility of a health risk is of considerable public interest.

The law may regard offenders as innocent until proven guilty, but where health risks are involved I suspect the opposite philosophy is more appropriate: regard things as potentially dangerous until proven otherwise.

Yes, I know nothing can *ever* be proven safe, in the scientific sense. But that just makes it even more important to keep an open mind regarding anecdotal evidence, doesn't it?

See you again next month, I hope. ❖

THE SERVICEMAN

Bringing our Serviceman index up to date...

Many readers tell us that the stories we present in this column are of considerable help when they have to track down a fault in their own, a friend's or customer's. The only trouble can be finding the stories about that particular model, when you need them. To help you with THAT one, we're devoting this month's column to providing an index covering the last nine years.

Back in January 1988, we presented an index of all subjects covered by The Serviceman between January 1975 — just before colour TV began in Australia — up to and including July 1987. The index presented here continues on from that first effort and presents a full listing of all subjects covered from August 1987 to March 1996 — a total of 104 issues and over 370 individual items.

In preparing this new index, we have tried to give an outline of both the symptoms and the cures, as discussed in the original stories. Space considerations have limited the amount of information that can be given, but every effort has been made to present enough detail to enable the identification of similar faults in the models discussed.

The classifications are based on the number of times a brand or model was discussed in the column. It is not intended to reflect on the reliability or otherwise of particular brands or models. CTV faults are listed first, followed by VCR faults and then other products marketed under that brand. Brands are listed in alphabetical order, in the main lists and also in the miscellaneous brands list.

In the Miscellaneous Subjects section, many of the products given as unknown brand or not stated model are in fact identified by description in the original articles. The reader is referred to that source for further details.

Each entry is of two lines, with the first line showing the the subject (CTV, VCR etc) and the fault symptom. The second line then shows the model number (if known), the cure and finally the issue date and page number. Entries where the page number is marked with an asterisk were TETIA 'Fault of the Month' items.

In the listing D/J stands for dry joint, u/s for unserviceable, o/c for open circuited and s/c for short circuited.

CTV	Irregular switch-off		
TC 53L2	Line driver transistor intermittent o/c	Oct 88	56
CTV	Fuse 903 (1A slo blo) fails repeatedly		
TC 53L2	Fuse too closely rated for old set: use 1.25A	Dec 90	73*
VCR	Will only play one tape a day		
6900	Loading motor drive belt slipping when warm	Apr 94	46

HITACHI

CTV	Intermittent no go		
CEP 288	Corrosion under solder pad at L780	Dec 93	48
CTV	No colour		
CEP 288	S/c in T552 chroma demod transformer	Jan 89	38
CTV	Teletext lines		
CEP 288	Increase value of C359 to 47uF	Sep 93	47
CTV	Won't start or starts and runs badly. B+ low		
CRP 141	C919 (3.3uF 25V) low value.	Sep 87	44*
CTV	White line and vertical distortion		
CTP 2065	C608 (22uF 160V) gone low value	Feb 91	65*
CTV	No vertical scan		
CTP 208	C611 (100uF 160V) open circuit	Jun 94	48
St.amp	No go. One channel output at -30V		
HA 330	R705 gone high and Q703 defective	Oct 89	80
VCR	Sound but no pix until thoroughly warmed up		
VT-20E	Q1159 (100uF/25v) heat sensitive	Jun 90	65

HMV

CTV	No vertical hold		
A 4301	Three faulty components in hold circuit	Feb 93	47
CTV	No pix. Tube heaters dark		
C221	Faulty chopper transformer	Oct 90	124
CTV	Sound OK but no picture		
C221	1/2Ω 2W resistor in pwr supply gone high	Jul 88	48
CTV	Erratic startup, hiccupping		
C221,231	TR102 (BR203) regulator SCR faulty	Feb 89	57*
B&W TV	No picture		
M7	1S2 (EHT diode) worn out	Feb 89	56
B&W TV	No brightness		
M7	Bad tube, faulty tuner, wrong R value	Sep 88	56
B&W TV	Fixing the customer, not the set		
M7	One customer I was glad to be rid of	Sep 89	65

JVC

CTV	No go		
7485AU	R903 (error amplifier feed) o/c	Sep 94	44
VCR	Stops soon after starting to play		
HR 7200	Reel drive belt stretched or broken	Mar 93	46*
VCR	No go. Fuse F4 open circuit		
7650	Replace D13, Q11 , Q15 and Q16	Jun 92	53*

KRIESLER (See also Philips)

CTV	Three faults in a week! What goes on?		
59-02	TCA540, tripler, resistor & capacitor all faulty	Nov 94	46
CTV	No sound or pix, then vertical lines after repair		
37-104	R644 open and wrong output transistor fitted	Nov 89	58
CTV	No horizontal hold		
59-01	R729 (4.7k ohms) gone low value	Dec 89	69
CTV	Pale, unstable pix		
59-01	IC241 (TDA540) IF processor faulty	May 94	46
CTV	Irregular flashing lines, wavy verticals		
59-03	Dry joint at R755. Defective tripler	Jun 89	67*
CTV	Channels shift up and down, intermittently		
59-03	Dry joints on main PCB	May 90	58
CTV	Intermittent small changes in picture height		
59-04	R629 (150k ohms 1/2W NTC) resistor faulty	Apr 89	154*
CTV	Intermittent flashing light and dark lines		
59-04	Dry joint on TDA2540 on IF module	Jul 89	66
CTV	Hiccupping		
59-06	Dry joints under various modules	Dec 92	46
CTV	Hiccupping		
59-09	Defective line output transformer overwind	Feb 91	62
CTV	No go. Tripler and line output transformer both damaged		
59-09	C563 & C564 (47nF) ceramics both defective	Sep 91	54
B&W TV	No pix — just a vertical line		
79-3	C159 (0.18uF) open circuit	Aug 93	43
CTV	Intermittent lines, dots and splashes of colour		
59-04	Dry joints. VCR mods needed	Jan 92	69
CTV	Sides of pix bowed inwards		
59-09	Core of L792 missing or misplaced	Oct 92	54*

NATIONAL and/or PANASONIC

CTV	No go. Buzz from power transformer. B+ only 58V		
TC 20AV	C583 (1200uF 160V) dried out	Mar 88	52*
CTV	No go. Buzz from power transformer. B+ only 58V		
TC 86A	C583 (1200uF 160V) dried out	Mar 88	52*
CTV	(1) Low height (2) Replace burned cabinet		
TC 1401A	(1) C463 (22uF/250V) o/c (2) Insurance job	Jul 89	68
CTV	No vertical scan		
TC 1802	C564 (10uF 250V) electro dry jointed	Aug 88	53*
CTV	Intermittent no start		
TC 1807	Overvoltage trip extremely sensitive	Aug 88	52
CTV	Teletext lines visible		
TC 1807	Modify blanking circuits	Feb 93	49
CTV	No go. Buzz from power transformer. B+ only 58V		
CP 2000	C583 (1200uF 160V) dried out	Mar 88	52*
CTV	Faint hum bars in picture		
CP 2000	TR851 (2SC647) regulator transistor shorted	Feb 90	57*
CTV	No go. Dark lines across screen		
TC 2002	Spring res in p/s open. IC301 video processor u/s	Jul 90	58
CTV	No picture. Sound OK		
TC 2037	Crack in PCB caused by faulty assembly	Aug 94	48
CTV	Intermittent sound and picture		
TC 2037	Dry joint at line driver transformer	Aug 94	50
CTV	No colour, image deflected almost off screen		
TC 2202	All mechanical adjustments fiddled	Mar 91	74
CTV	Turning sound down makes resistor burn up		
TC 2223	Transposed leads at volume control	Jan 92	67
CTV	Bright blue screen. Heater/cathode short		
TC 2620	Isolate heater & supply from line transfmr	Jul 92	58
CTV	Large black area in bottom rightcorner of screen		
TC 2657	Bad contact in yoke plug DY	Oct 93	50
CTV	Sound OK but no pix		
TC 68A61	Dry joints at heater pins on tube base board	Dec 93	51
VCR	South African model won't work in Australia		
NV G7	Problems with conversion to Australian standards	Dec 88	56
VCR	Won't work. Cassette stuck in mechanism		
NV G20	Replace ALL electros in power supply	Oct 95	48
VCR	Won't play its own sound		
NV G22	Faulty pinch roller	May 93	43
VCR	Won't record anything		
NV H70A	Adjust record current	Dec 92	49*
VCR	No sound on EE only		
NV 300A	Tuner/line input switch broken	Dec 93	52
VCR	Bad off-air pix, mechanical problems		
NV 370A	P/S filter cap gone low, replace idler roller	Jun 90	63
VCR	No clock, no display, no functions		
NV 370A	R1011 in power supply open circuit	Sep 92	50*
VCR	Low output from one head, like dirty heads		
NV 370A	Rotary transformer windings loose in slots	May 94	48
VCR	Machine won't operate. Mechanism gummed up		
NV 450	Owner used shaving cream to clean heads!	Aug 94	73
VCR	Noisy pix, improving after 10 minutes		
NV 600	IC201 and C2004 (10uF 16V) both faulty	Nov 90	73
VCR	Erratic, unpredictable behaviour		
NV 777	Not cured but minimised by removing AC power	Jan 96	44
VCR	Restoring machine found on junk pile		
NV 7200EN	Two drive belts slipping	Nov 95	48
B&W TV	Snowy picture		
TR 171	Bad connection to spade terminals on balun	Oct 89	78
El.flash	Slow recharge, then no go		
PE 2850	Leakage from high voltage rail on PCB	May 93	44

NEC

CTV	No go. Line output transformer defective		
N 3410	'Identical' replacement trx NOT identical	Jul 93	46
CTV	No go		
N 3419	Dry joint at 12V rail regulator	Oct 94	44
CTV	No sound, no volume control		
N 3430	Volume up/down buttons broken inside cabinet	Jul 92	61*
CTV	No go		
N4380	Replace STK73410/II and check modifications	Mar 95	43
VCR	Sound OK but no picture		
N/S	Dirty video heads	Jul 89	67
VCR	Won't play one particular cassette		
9033A	Light passing through translucent cassette	Dec 91	68

PHILIPS

CTV	Intermittent but regular vertical collapse		
CP 510	Q520 (BD233) output transistor breaking down	Sep 88	59*
CTV	No sound		
CT 2006	C2177 (22nF/50V ceramic) leaky	Jun 90	66*
CTV	Intermittent sound		
GR 1055	Wire link missed solder in factory	Nov 95	49
CTV	Badly bent horizontals		
K 9	Break in copper track near pincushion transductor	Apr 89	153
CTV	Low height		
K 9	C547 (100uF/25V) gone low in value	Apr 90	62*
CTV	Pulsating width variations		
K 9	Width control trimpot defective	Aug 88	52
CTV	Blue pix		
K 9	Leaky tube base board.	Jul 87	62
CTV	Weak pix		
K 9	Bad tube.	Jul 87	60
CTV	Retrace and teletext lines visible on screen		
K 9	C265 (22uF 63V) open circuit	Jun 88	48

CTV	Notes on erratic power supply	Mar 89	46
CTV	EHT — Extremely High Tension		
K 9	C446 (third harmonic tuning capacitor) low value	Sep 89	64
CTV	Bad E/W pincushion distortion		
K 9	D540 (BYX55/350) leaky	Sep 89	66*
CTV	Multiple faults in junked set		
K 9	Resistors, electros and ceramic caps all bad	Sep 91	56
CTV	Small, snowy pix		
K 9	Part of C179 (dual electro) open circuit	May 91	53*
CTV	No go		
K 9	Switch u/s, chopper s/c, and other faults	Sep 95	22
CTV	Weak or no horizontal sync		
K 11	D608 (BAW62) short circuited	Oct 89	81*
CTV	Very low height		
K 11A	C575 (1000uF 16V) gone low value	Jan 96	46
CTV	Very bright, white screen with retrace lines		
K 11	R606 (or less likely S610) open circuit	Dec 89	69*
CTV	No picture, just coloured blob		
K 11	Focus resistor (5.6 megohms) open circuit	Oct 92	50
CTV	Very low height		
K 11A	C575 (1000uF 16V) gone low value	Jan 96	46
CTV	No go		
KE 027	Power transformer defective	Jan 89	36
CTV	Picture takes as long as ten minutes to appear		
KE 028	C430 (100uF 63V) defective	Aug 89	68
CTV	No sound		
GR 100	Set in 'hotel' mode. Code needed to unlock	Dec 91	68
CTV	Intermittent colour		
KH 658	Solder in ICs in chroma module	Dec 93	52
CTV	No picture, sound OK		
CT 6050	R3050 off line output transformer o/c	Jul 91	40*
CTV	Hiccupping		
KL 9A	Dry joint on C567	Jan 93	59
CTV	Loses channels and all settings after two days		
KL 9A	Backup battery won't hold charge	Nov 90	74
CTV	Intermittent start		
KT 2A-2	Dry joint at collector of reg. transistor	Oct 93	50*
CTV	Bright screen, retrace lines. No sound		
N/S	R3583 open. No antenna mutes sound	Dec 90	72
CTV	(1) Bad colour (2) intermittent shut-down		
N/S	(1) Degauss (2) D/J on line output transistor	Jul 89	67
CTV	Intermittent fine tuning		
N/S	Dry joint in tuner oscillator	Dec 87	41
PIRdet.	Bad performance during development		
N/S	Cheap unit suffers from gravity effect	Jul 93	45
Radio	Severe distortion		
113B	Wrong rectifier valve & unstable grid resistor	Feb 89	56
Stereo	Weak sound on all functions		
AS 5015CD	Speakers plugged into surround sound sockets	Dec 93	51
VCR	No go. Cassette stuck in mechanism		
VR 674	Dried out electros in DC-DC converter	Nov 94	44

PYE (See also Philips)

CTV	Intermittent vert. collapse and/or total loss of picture		
T 29	Dry joints under heavy components (T1 & L502)	Dec 89	66
CTV	No vertical scan		
T 29	Q504 (BC638) faulty. Tests OK but won't work	Nov 90	75*
CTV	Bright white screen then shut down		
T 29	C816 (47uF 25V) open circuit	Sep 91	57
CTV	Repeated failure of line output transistor		
T 30	R626 (2.2 ohms 1/2W) open circuit	Apr 88	51*
CD	No programme play?		
CDR 3000	Wrong instructions in user manual	Oct 91	40

RANK ARENA (See also NEC)

VCR	No off-air image or recording. Play OK		
RV 320	Off air only available in rec mode	Jul 90	59
CTV	No horizontal hold		
C 1814	TH501 defective	Jan 91	66
CTV	Weak or no sync		
C 1851	C556 off the sync amp gone low value	Dec 89	68
CTV	Intermittent shutdown		
C 1412	C516 (8000pF 1.5kV) gone low	Jan 91	64
CTV	Volume control varies brightness, contrast and colour		
C 2205	C351 (100uF 16V) electro dried out	Apr 88	48
CTV	Notes on queer results when C351 is faulty		
C 2205	See also Apr 88/48	Sep 88	58
CTV	Intermittent darkening, pincushion distortion		
C 2230	D555, D559 or D560 intermittent open circuit	Feb 88	46*
CTV	No sound, no go		
C 2251	Parts missing after bodged repair	Aug 92	59
CTV	Dark pix		
C 2603	D555, D559 or D560 open circuit.	Jun 89	81
CTV	EHT breakdown in tripler. Yellow pix		
N/S	Repair tripler with hot melt glue. Boost blue gun	Aug 93	44
CTV	No go. F601 o/c. Confusion over dummy load		
C 2204	TR691 series regulator not working	Jun 88	46
CTV	Notes on p/s regulation on dummy load		
C 2204	See also Mar 89/47	Mar 89	47

SANYO

CTV	Owner gets shock from power switch		
2750	Metal shaft vol/power switch fitted to live chassis	Dec 87	56*
CTV	No or dark picture. Controls have no effect		
5603	C603 (4.7uF 25V) on tube base board open circuit	Oct 88	59*
CTV	Won't work in TV mode, only in AV		
CPP 3001	Front panel changeover switch jammed	Feb 94	30
CTV	Repeated failure of line output transistor		
CTP 3001	Change C315 from 12nF to 15nF	Nov 94	45
CTV	No go. All supply rails low		
CPP 3001	Line output transistor (2SD1649) defective	Apr 94	44
CTV	Q451 (2SD869) line output transistor short circuited		
CTP 3618	C314 (47uF 25V) low value	Jul 88	50
CTV	No go		
CTP 3618	R302 (390k ohms) open circuit	Nov 89	56
CTV	No go		
CTP 3612	Chopper transistor base res. gone high	Sep 94	44
CTV	Low height		
CTP 5601	Vertical output transistor o/c base-emitter	May 90	62*
CTV	No go and other faults		
CTP 6631	C314 (47uF 50V) intermittent open circuit	Feb 95	44
CTV	No pix, only faint hiss from speaker		
CTP 6631	D305 (8V zener) shorted	Jul 95	45
CTV	No go then no sound		
CTP 7602	Loose screws securing main board to chassis	Jul 88	49
CTV	No go. Chopper dead		
CTP 7605	Dry joints at C310 casing	Sep 90	48*
CTV	Overbright pix with retrace lines		
CTP 8601	C473 (10uF 300V) electro open circuit	Mar 95	42
CTV	Rapid vertical bounce		
CTP 8604	C203 (4.7uF electro) defective	Apr 93	30*
CTV	Vertical bounce and intermittent rolling		
CTP 8604	C203 (4.7uF 25V electro) gone low value	Jan 93	58
CTV	Dark screen. No A1 voltage		
CTP 8604	Restored by 'judicious butchery'	Sep 90	44
CTV	No go. R902 and R903 very hot		
CTP 8653	Short through mica under line output transistor	Dec 93	51
CTV	Distorted sound		
79P	Electro reversed — PCB wrongly labelled	Jul 93	45
CTV	Severe vertical bounce		
79P	C436 (10uF 16V electro) faulty	Jun 93	47*
CTV	Intermittent loss of vertical hold		
79P	R437 (33 ohm 2W) faulty	Jul 93	45*
CTV	Touch tuning system stuck on one channel		
80P	Plastic tuning pads damaged by cat urine	Aug 95	40
CTV	Dark pix		
83P	R234 (82k ohms) open circuit	Oct 92	52
CTV	Badly scratched screen		
N/S	Emergency repair using clear wax to fill scratches	Oct 92	51
VCR	Hum bars on all high band channels		
VCT 5300	C5002 (47uF 100V) open circuit	Apr 91	49*
VCR	No off-air pix. No record		
VCT 5300	Q1041 (Mute driver) transistor faulty. Corrosion.	Apr 90	58
VCR	Noisy lines across screen		
VCT 5300	C5007 (470uF 16V) electro open circuit	Jun 91	57*
VCR	Weak sound on tape playback		
VHR 5300	Dirty audio head	Dec 93	51
Rad/cass	Squeak recorded on tape as machine switched off		
RD W340	Misplaced microswitch	Oct 88	58
Rad/cass	Dial stringing problems		
GXT 4503K	Service manual diagram incorrect	Oct 89	80

SHARP

CTV	White screen. R1127 fails often		
8C220	C716 open circuit.	Jul 87	63*
CTV	White screen. R1127 fails often		
8C223	C716 open circuit.	Jul 87	63*
CTV	No vertical scan		
C 146X	Q503 defective	Nov 87	33
CTV	No sound, no pix. STR4090 in p/s shorted		
CX 1464	C712 (33nF 630V) intermittent breakdown	Aug 92	58

CTV	Tuner drifts off channel after 10 minutes or so		
N 1426A	Dried electrolyte in detector coil can	Mar 90	61
CTV	No go		
DV 1600	Check batteries in (docked) remote control	Jan 93	58*
CTV	Blows main fuse repeatedly		
CX 2032	Wrong antenna socket fitted	May 92	50
CTV	Retrace lines		
CX 2232	Electro across base/emitter of Q512 gone low	Jun 94	46
CTV	No go. Remote control inoperative		
DV 4884	Primary winding on T2001 open circuit	May 92	50
CTV	No on-screen display		
DV 4884	Sync lead to display IC dislodged	Sep 92	48
CTV	Blown up after antenna repair		
N/S	No isolating caps on antenna socket	Aug 89	66
CTV	Grotesque colour distortion		
N/S	Yoke misplaced when glued-on bond failed	Dec 92	48
VCR	Tangles tapes and other mechanical problems		
VC A111X	Dirty mode switch	Dec 93	51
VCR	Snowy pix on all channels		
VC 381X	Obscure fault in track between tuner & IF strip	Jun 91	54
VCR	Tape running fast, as in speed search		
VC 386	Plug 'NB' in capstan servo chain disconnected	Oct 91	43*
VCR	Pronounced flutter in sound		
VC 386X	C732 (10nF) capacitor defective.	Aug 91	49*
VCR	No go		
VC 387	Various components on complicated power supply	Jun 92	54
VCR	No go. No power supply output		
VC 387X	A box of dud electros(!)	Apr 93	27
VCR	Flutter in sound		
VC 481	Faulty capstan drive belt	May 90	61
VCR	Noisy pix after replacing video heads		
VC 488	Pre-aligned heads were not pre-aligned	Feb 90	57
VCR	Odd malfunctions, similar to faulty mode switch		
VC A502X	IC701 (IXO3222GE) intermittent	Dec 93	50*
VCR	Goes into FF after Play pressed		
VC 583X	Clean heads. Goes into auto search mode	Nov 92	61*
VCR	Stops soon after PLAY pressed		
VC 8300	Drum motor defective	Sep 93	47*
VCR	No go, no activity of any kind		
VC 9100	Brownish rubber deposit on regulator board	Feb 93	48*
VCR	Odd kind of flutter in sound		
N/S	Speck of some hard deposit on head drum	Mar 94	44
Radio	Intermittent on FM band		
GX CD75XI	C602 (AM/FM detector) heat sensitive	Jul 95	44

SONY

CTV	Reduced height and foldover		
KV 1300AS	R556 (220 ohms 1/2W) open circuit	Dec 88	59*
CTV	UHF tuner won't work		
KV 1300AS	Q212 (2SC1364) defective	Jan 89	40*
CTV	Thermal cutout trips frequently		
KV 1310E	D609 (MZ-12) 12V zener open circuit	Nov 87	34*
CTV	Intermittent channel change		
KV 1400AS	(1) P/S interruptions (2) grimy touch pads	Mar 92	51*
CTV	Won't start		
KV 1612AS	R603 (47k ohms 1W non-flamable) open circuit	Mar 89	49*
CTV	No pix until set thoroughly warm		
KV 1830AS	Intermittent o/c in Q309 collector load	Aug 90	49*
CTV	Won't start up, power supply hiccupping		
KV 1830AS	Line output SCR (SG613) open circuit	Nov 89	58*
CTV	Intermittent shutdown		
KV 2764	External speakers overloading audio IC	Mar 92	50
VCR	Warble or flutter in sound		
SL C35AS	Check setting of tracking control	Aug92	60*
Clock/rad	No clock function		
N/S	Power lead to clock mechanism broken.	Oct 87	36
Rad/cass	Intermittent sound		
N/S	Faulty mute transistor	Oct 92	50
Stereo	Problems with connecting audio and video		
STR AV1070X	Video switching defective	Dec 95	47

THORN (see also AWA)

CTV	No sound or picture		
'G' chas.	Q102 (2SC710) video amp defective	Jan 90	83*
CTV	Sound varies up and down quite suddenly		
N/S	Lead on speaker terminal never soldered	Jul 90	59
CTV	Partial vertical collapse		
TX 100	Replace TDA3652 with TDA3654, plus mods	Mar 93	45
CTV	No colour		
9001	Defective ceramic caps on chroma board	Jul 91	36
CTV	Set dead		
9007	C535 (100uF electro) faulty	Oct 92	51
CTV	Slight horizontal shakes		
9105	Faulty fuse in power supply	Apr 91	46

VCR	Intermittent buzz in sound		
AV 20	RF out changeover switch dirty	Dec 95	48

TOSHIBA

CTV	No colour		
C 412	TA7148P chroma processor faulty	Mar 91	74*
CTV	No colour		
C 810	Dry joints at pin-throughs on mother board	Jul 89	67
CTV	No colour		
C 810	Dry joints on plug in chroma board	May 88	45*
Radio	Broken cassette door.		
'Bombeat'	Repair with polystyrene cement.	Oct 87	34
Copier	Confused responses to controls. Mangled paper, dirty copies		
BD 4511	HV leakage from coronas, worn mechanical parts	Mar 88	50

MISCELLANEOUS BRANDS & MANUFACTURERS

Aerovision			
Balun	Intermodulation effects from Channel 2		
N/S	Corrosion on antenna connections	Nov 88	56
AMI			
Jukebox	No go. Minus 7V rail short circuited		
R82	Panel lamp shorted internally	Apr 88	49
Ampex			
Pro VCR	Two of four video heads not working		
VPR 300	Demo of error correcting capability	Oct 91	42
Tape dup.	Servicing professional tape decks		
350 Series	Looking after a Master and seven Slaves	Jan 95	42
Apple			
Computer	Erratic read and save functions		
IIc	Radiation from badly positioned power supply	Jun 89	66
ASEA			
Dishwasher	Wrong or no functions		
N/S	Blocked sensors	Feb 94	28
Barlow-Wadley			
Radio	Won't switch on		
XCR 30	Faulty transistor acts more like an SCR	Dec 95	49
BBC			
Computer	Random characters added to text in W/P		
Model B	Overheated video processor	Jun 93	46
Computer	Random characters in Modes 1 to 6		
Model B	6502 upc faulty	May 93	42
Beaulieu			
Projector	Speed problems with sound film only		
708 EL	Faulty LDRs in sync loop.	Aug 87	43
Blaupunkt			
CTV	Frequent failure of R1140		
Cardona	Dry joints under thick film on vertical board	Jul 89	68*
Canon			
Calculator	Intermittent faults of various kinds		
N/S	D/J on pin throughs. One hidden under IC!	Jan 95	45
Commodore			
Disc drive	Won't load some discs		
1541	Low mains voltage	Nov 90	74
Decca			
CTV	Intermittent vertical collapse		
104	Various faults in vertical output and p/s	Feb 88	44
Dick Smith Electronics			
Computer	Garbage on screen at startup		
System 80	Faulty 4116 RAM chip.	Sep 87	40
Electronics Australia			
Power supply	No go. DC fuse open circuit		
VK Powermate	Control IC and output transistors faulty	Mar 92	48
Inverter	No output		
300W	Impurity in PCB material shorting divider chain	Mar 90	58
Fisher			
VCR	No EE, no off-air recording		
FVH-P620	IC01, 0.47uF 50V electro in IF module faulty	Apr 92	38
VCR	No take up tension		
FVH-620	Idler tension spring stretched	Aug 88	53
Ford			
Car electrics	Wow and flutter in cassette player		
N/S	Fault in car earth wiring	Jun 95	42
Fordigraph			
Typewriter	Overprinting. Carriage motor fails after warm up		
N/S	2SD718 series regulator faulty	Sep 94	42
GAC			
CTV	Weak, washed out pix. No sync		
C14AS	All electros fitted wrong way round	Dec 90	70
GEC			
CTV	No sound or picture		
2213A	R503 (22k ohms) open circuit	Oct 90	126*
CTV	(1) Retrace lines (2) Loud screech from p/s		
2213A	(1) Change value of R604 (2) Dried electros in p/s	Feb 89	54
CTV	Power supply hiccupping		
C2214	Line output transformer defective	Aug 88	50

GEM			
Organ	Intermittent bass pedals. Broken leaf spring		
150	Clean contacts with WD40 and retension	Jun 89	65
General			
CTV	Broken picture tube neck		
N/S	Difficult disassembly procedure	Nov 87	32
Graetz			
CTV	No go after period of intermittent shutdowns		
N/S	Broken lead in power cord	Mar 92	51
Hammond			
Organ	Serious hum level. Other small faults		
Regent	Defective connector to Leslie speaker amplifier	Oct 94	45
Heathkit			
Tuner	No go. No B+ rail		
N/S	Power transformer primary open circuit.	Oct 87	35
Hewlett-Packard			
Computer	Faulty screen display - random characters		
HP 150	Replace character ROM, blow new EPROM	Apr 92	36
JIL			
Scanner	Audio muted and very weak		
SX 200	C235 (10uF 10V) leaky	Aug 95	41
Kemtronics			
Clock/radio	Switches on spontaneously		
DE 221	1000uF/16V & 470uF/25V gone low in p/supply	Feb 93	46
Korting			
CTV	No go. Fuses and other components blown up		
N/S	Dangerous substitute resistor loose in cabinet	Dec 87	54
Labtech			
CRO	Bright defocussed line		
N/S	Q301 (2SA968) and U301 (uA741) defective	Oct 93	48
Lemair			
B&W TV	No go		
KQ 35	Resistor 2R8 (4.7 ohms 1/4W) open circuit	Jan 91	67*
Lister			
Diesel alternator	Engine won't start		
N/S	Burnt relay contacts and other faults	Jun 95	48
MATV			
Antennas	Problems with installation of dual antenna systems		
	Solved by the use of home made bandpass filters	May 89	58
Philco			
CTV	Stopped with a loud bang		
1A47	Second scan thyristor (THR2) faulty	Dec 87	55
CTV	No vertical scan		
1A47	Scan SCR THR2 (16121) faulty	Oct 87	37
Phodis			
Stereo	Noisy signals and bad hum		
N/S	Loose input plug and badly installed filter cap	May 92	48
Precedent			
CTV	Intermittent loss of horizontal sync		
C 810	Dry joints under video detector chip	Aug 89	70*
Princess			
CTV	No vertical hold		
14CT8	Q201 (1st video amplifier) defective	Feb 92	45
CTV	Picture slow to appear		
14CT9	C310 (100uF electro) on vertical chip faulty	Dec 92	47
B&W TV	No go		
N/S	PNP used instead of an NPN transistor!	Dec 89	66
Rad/TV	No sound. Pix OK		
TCR 53SGA	Radio/TV changeover switch faulty	Sep 95	24
Samsung			
CTV	Snowy screen with no channel or sound		
CB 3325J	33V tuning rail missing. RR05 gone high	Jun 94	46
CTV	Severe top foldover		
CB 677Z	Output transistors faulty. Use BD203/204	Dec 93	52
VCR	Loading motor drive IC missing		
N/S	Childs play	Nov 93	46
Sherwood			
Stereo	Blown fuses, STK4191 shorted		
CTA 44	Voice coil in speaker shorted turns	Jun 90	62
Stromberg			
Radio	Very slow to come on		
N/S	Internal short in converter valve	Jul 95	43
Tandy			
Cass. rec	Mechanism squeaking		
N/S	Lubricate with WD40	Oct 87	35
Teac			
VCR	No rewind or fast forward		
N/S	Deformed rubber collar on nylon lever	Oct 92	51

Telefunken			
CTV	Tuning problems		
816	No faults, just complicated and confusing	Dec 95	46
VCR	Tuning problems		
N/S	No faults, just complicated and confusing	Dec 95	47
Titan			
CTV	Intermittent No Go		
TS 201	Breaks in copper track	Jan 90	80
Yamaha			
CDP	Won't play		
CD X3	Moulded supports under deck broken	Aug 91	48

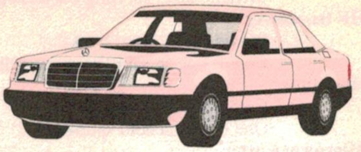
MISCELLANEOUS SUBJECTS

(Brands and/or model numbers unknown)

AC mains			
	RFI following lightning strike		
	Loose connection on power board	Oct 94	47
Alarm systems			
	False alarms		
	Microwave oven interlock jammed	Dec 93	50
	PIR sensors not working in new building		
	Moisture sensitive due to flux residue	Dec 94	40
	False alarms with microwave detectors		
	Interference from fluorescent lights	Oct 95	46
	Repeated false alarms from soon after new		
	Ants gained access to PIR sensor	Sep 93	46
	Early morning false alarms		
	Cockroaches in microwave detector	Dec 94	41
Alternator, 240V			
	Sudden loss of output		
	Shorted turns in exciter transformer	Aug 94	50
Amplifier			
	Savage bite from unplugged power lead		
	Surge protection caps badly located	Oct 93	48
Avionics			
	Problems with aircraft antennas		
	Installation errors	Jul 94	51
Bingo display			
	One number not working		
	Switching transistor open circuit	May 90	60
Car cassettes			
	Repeated failure of protection diode		
	Voltage reversal in old VW car	Nov 94	47
Car electrics			
	Capacitor in distributor repeatedly shorted		
	Defective coil	Feb 92	44
	Intermittent misfiring when hot		
	Faulty transistor in distributor	Aug 90	46
Car radio			
	Intermittent, uncontrolled ON/OFF		
	Random leakage in 10 pin plug	May 94	49
Cassette recorder			
	Tape jammed		
	Cassette takeup hub misplaced.	Oct 87	34
CCTV camera			
	Picture keeps flipping upside down and back again		
	Dry joint at inverting lens flylead	Aug 90	47
Colour TVs			
	Faulty picture tube, line output transistor and tripler		
	Large spider shorted tube base connections.	Feb 88	45
	Severe shock when attaching antenna		
	Crude and dangerous repair to ultor cap	Feb 92	45
	TV switches on spontaneously		
	Resident ghost in old English inn	May 95	41
Computer			
	Unable to access data in bank computer		
	Broken cable to disc drives	May 91	50
Computer power supply			
	Won't start up		
	390k ohm 1/4 watt resistor underrated	Dec 90	72
Electric fences			
	Fence pulses reaching 'Front Door'!		
	Broken earth return at controller	Dec 91	65
	Loud BANG at midnight		
	Electro exploded after SCR failed	Dec 91	66
Electronic organ			
	Failure of most couplers		
	Burnt up diodes on control boards	Jul 94	48

(Continued on page 49)

AUTOMOTIVE ELECTRONICS



with NICK de VRIES MIAME, AMSAE, FI Diag.E.

The EA Falcon's EECIV electronic fuel injection

The Ford EA Falcon employs the EECIV engine management system. There are variations on the engine size and injection type, but all of the EECIV systems are very similar for the EA generation. The main difference is the type of injection system implemented, which can be either multipoint (MPI) or central (CFI) fuel injection. The two different systems will be covered, but I will mainly be discusing the multipoint 3.9-litre six cylinder version.

As mentioned, the MPI vehicle is a six cylinder 3.9-litre engine with an EECIV engine management unit — which means it controls fuel injection, spark advance, idle speed and emission devices.

The EECIV system is a speed density type, meaning it relies on the throttle position sensor, (TPS), air (charge) temperature sensor (ACT) and manifold vacuum (via the manifold absolute pressure or 'MAP' sensor) information to determine the correct injector duration. The O_2 sensor, mounted in the exhaust manifold, also monitors variations in the exhaust gas so that injection can be modified to optimise the mixture.

The various external devices which form part of the MPI system are shown in Fig.1, together with their wiring and connections to the ECM. Twelve volt DC power is connected to the ECM continuously via the KAPWR line (pin no.1), so that the ECM can retain fault codes and also store data about the O_2 sensor feedback, MAP sensor, TPS and engine condition. As engine wear occurs the fuel injector curve (milliseconds of 'on' time) and ignition curve can be adjusted to optimise fuel effeciency and power. So when a new unit is installed, it may need three or four kilometres to settle into its new 'home'.

The ECM controls the various operating modes, i.e., underspeed mode, closed throttle mode etc. In this sense it is similar to the XF system (see the XF article in *EA* for May 96).

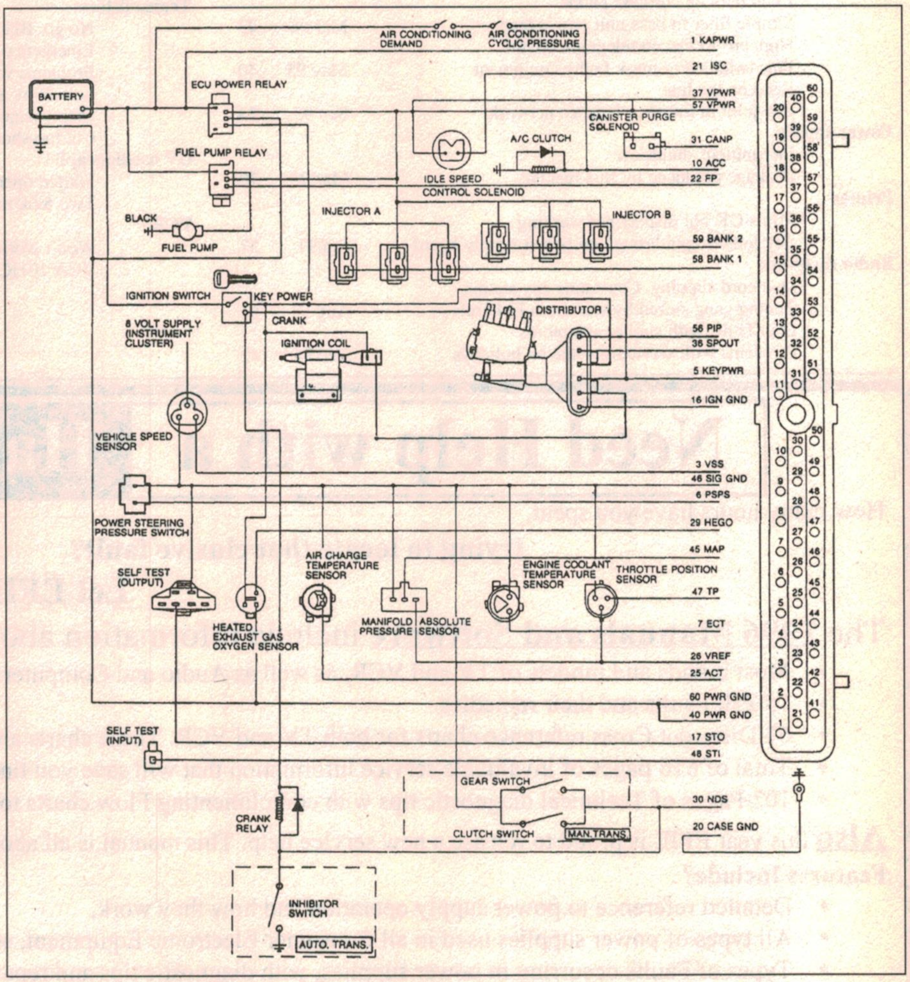


Fig.1: The EA Ford MPI system devices and connections. (Diagram courtesy of the VACC Technical department)

System hardware

The system includes the normal injection hardware and the ignition system has the Ford 'trademark' grey TFI (thick film ignition) module, mounted on the side of the distributor that also incorporates the Hall sensor trigger for the system. There is a three wire (heated) O_2 sensor in the exhaust manifold, so we can assume the ECM has a closed-loop mode and unleaded fuel must be used. (Leaded fuel coats the O_2 sensor, reducing its effective lifespan. It also has the same effect on the catalytic converter.)

The coolant temperature sensor (CTS) provides the ECM with a voltage relative to the engine temperature, so that cold start, warm up enrichment and other various control modes can be invoked. The CTS is mounted in the thermostat housing on the front of the engine.

Other devices that provide information to maintain idle quality are the neutral drive switch (NDS), aircon request (ACC) and power steering pressure

switch (PSPS). These devices all indicate to the ECM that the driver has selected a mode where additional load will placed onto the engine, so to maintain idle speed and quality the ECM takes appropriate action via the idle speed control (ISC) solenoid, which is mounted across the throttle plate.

The vehicle speed sensor (VSS) indicates vehicle speed to the ECM, so that injector decell cutoff can be achieved on the MPI engine can be acheived. It also allows entering the lean cruise mode.

The ECM also has diagnostic capabilities, and codes can be retrieved by shorting the STI input to ground and connecting an LED tester between the battery and STO pin. The canister purge valve (CPV) is controlled by the ECM and is opened when under certain conditions, via the CANP line.

The MAP sensor outputs a frequency proportional to the engine vacuum. The signal should be a 5V square wave, and it can be checked on pin 45 of the ECM. Fig.2(a) shows the frequency/vacuum relationship. The MAP sensor and TPS are supplied by the ECM with +5V DC (pin 26: VREF) and ground (pin 46: SIG GND).

Fig.2(b) shows the coolant temperature sensor and air charge temperature sensor resistance versus temperature characteristic.

VACUUM (in Hg)	FREQUENCY (Hz)
0	155
10	125
20	95

Fig.2a: The MAP Sensor outputs a frequency that is proportional to engine vacuum.

TEMPERATURE (deg C)	RESISTANCE (Ohms)
100	2.070K
80	3.845K
40	16.150K
20	37.300K
10	58.750K

Fig.2b: Temperature versus resistance for the CTS and ACT sensors.

ENGINE (Litres)	TRANS.	INJECTION	ECM ID CODE	PART No.
3.2	Auto	CFI	70	87DA12A650 FX
3.2	Manual	CFI	60	87DA12A650 EX
3.9	Auto	CFI	50	87DA12A650 DX
3.9	Manual	CFI	40	87DA12A650 CX
3.9	Auto	MPI	30	87DA12A650 BX
3.9	Manual	MPI	20	87DA12A650 AX

Fig.3: The different variants available in the EA range have ECMs that suit the individual vehicles. Note the X on the end of the part number — this means that this number is not significant and should be ignored. Later models may have a 90DA prefix.

Fuel system

System fuel pressure on the MPI vehicle is set to 250kPa (200kPa at idle), compared with 100kPa on the CFI vehicle. The fuel pump (FP) is under ECM control, and when pin 22 grounds (engine cranking or running) the fuel pump relay energises and supplies power to the fuel pump.

The injector solenoid resistance is approximately 16 ohms on the MPI system and 1.4Ω on the CFI system. This presents a problem because if a MPI unit is installed into a CFI vehicle and an attempt is made to start the vehicle, there is a possibility of damaging the injector driver stages. So ensure you have the correct part number installed in the vehicle when replacing the unit! (See Fig.3 for the part number listing.)

Both the CFI and MPI systems have two injector output stages (banks 1 and 2, on pins 58 and 59). There is one injector connected to each bank on the CFI model and three, in parallel, connected to each bank on the MPI model.

The injectors fire in completely different modes on the respective vehicles. The MPI system fires alternate injector banks once every three ignition pulses — or when cranking, on every ignition pulse.

In contrast the CFI system injectors fire alternatively on the positive edge of each PIP signal, for warm idle mode, and on the positive edge for bank A and then on the trailing edge of the same PIP pulse for bank B, when in 'part load' mode. 'Decell mode' spreads the triggering over two PIP signals, while in crank mode both banks (as with the MPI system) fire on every PIP pulse.

The fuel pump is located in the fuel tank, on both the sedan and the wagon, and should deliver at least 800cc of fuel in 30 seconds — with the battery at +12volts!

Ignition system

The EA's EECIV ignition system is very similar to the XF system, that is the distributor has a Hall sensor inside which interfaces directly to the TFI module. The TFI has six connections (see Fig.4), but the SPout wire does not have the green connector found on the XF.

Instead of disconnecting the SPout connector to adjust the base timing, on the EA EECIV system the code mode is entered by shorting the STI connecter to ground. The ECM then holds the timing steady for approximately two minutes, so the base timing can be adjusted. If the timing cannot be adjusted within this time, the engine will have to be switched off for at least 15 seconds and the sequence restarted. Base ignition timing is set to 10°.

The Hall sensor inside the distributor is different on the MPI and CFI vehicles. The rotor that interrupts the magnetic field is the main difference. On the CFI engine the cutouts and vanes are of equal length, so a square wave is generated; however the MPI engine has a rotor with one short vane. This is relative to the No.1 cylinder position and therefore indi-

cates crankshaft position.

The PIP signal, as with the XF system, triggers the ECM and it has a nick out of the corner of it to indicate the active timing mode. The SPout signal also has timing information superimposed on it, and the TFI module uses this information to switch the coil at the correct time.

There is +12V supplied to the TFI module from the ignition switch. One supply is normal power and the other is the crank input. When cranking, the TFI module uses base timing to start the engine; but once started the ECM controls the timing.

A basic test on the distributor, off the car, can be done quite easily. Connect the TFI module up with +12V to the supply pin. The negative coil pin connects to an LED tester (pulled up to +12V) and signal ground and the distributor body to ground. When you rotate the distributor shaft, the LED should flash. This doesn't test all of the features of the TFI module, but it does give an indication of the trigger circuit integrity.

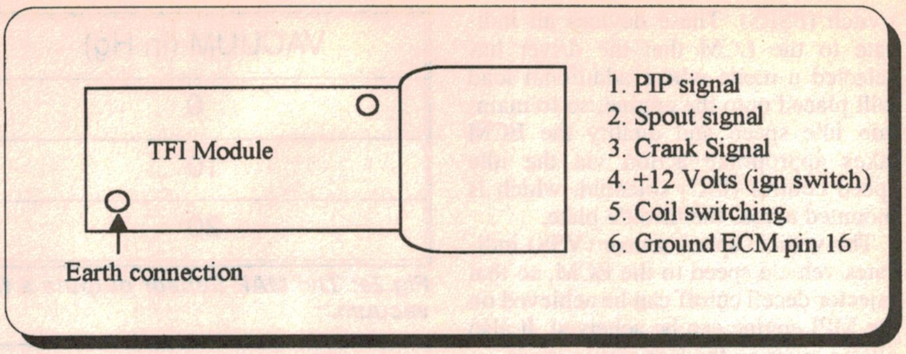


Fig.4: Connections to the TFI module

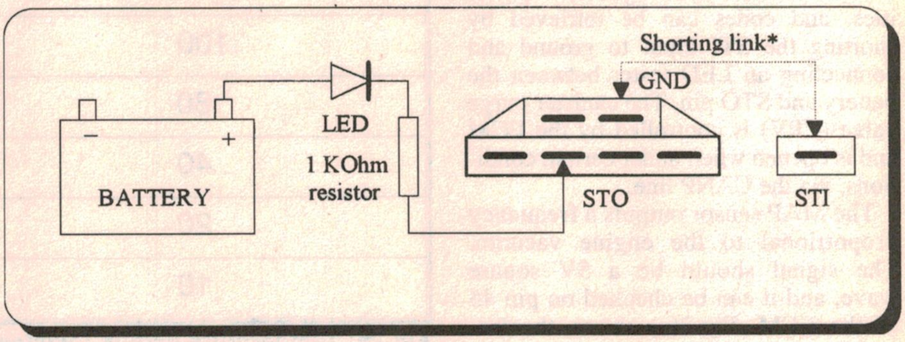


Fig.5: Connections for diplaying the diagnostic codes manually, with an LED and current limiting resistor.

Earth connections

Pin 16 of the ECM (IGN GND) is a dedicated (quiet) earth for the ignition system. This is a reference earth for the TFI module, and does not carry the coil switching current. The heavy coil current grounds through the screws on the TFI module to the distributor body. The reason for this separate earth via pin 16 is to reduce noise and provide a good reference for the ignition control signal, for reliable operation.

While we are on the subject of Ford earths, Rex Vandenberg (the MD at Melbourne ECM specialist Injectronics) was telling me that lately he has had an automotive workshop with a late model Ford that was running quite 'ragged' — e.g. heavy fuel consumption, rough running and hard starting. The power supplies and the inputs tested OK, except a 'rich' running signal was apparent on the O2 sensor wire. The customer was adamant that all power supplies and grounds were OK.

The ECM was sent to Injectronics for testing, because there was a small bias voltage (approximately 3V) on the O2 sensor pin with the O2 sensor disconnected. Normally this pin should have zero volts...

Upon bench testing the unit, it was discovered that the ECM O2 pin did have 0V on it, and performed faultlessly. So the unit was returned to the trade customer, but the fault was still apparent.

Upon further testing, it was found that the earth (pin 49 — Hego reference ground, not shown in Fig.1) was quite resistive (i.e., disconnected). On the V8 vehicle it is hidden amongst the hoses and wires around the rear of the engine.

So this story reinforces the fact that all of the power supplies, auxillary supplies, grounds and reference grounds should be checked thoroughly. The solution to the above problem was quite elusive, because it was only a very small voltage that caused quite a major problem.

Before I proceed, I should perhaps mention that Injectronics is an Australian owned company that remanufactures automotive electronic components for automotive workshops all over Australia. Unfortunately it is not a retail company; they only deal strictly within the automotive trade network.

If you are not a trade customer and you feel that your ECM does need testing, you can always contact your local automotive technician for advice. Upon testing, they may recommend the ECM be sent off for further testing by a firm such as Injectronics. But direct trade

CODE	DESCRIPTION	CODE	DESCRIPTION
11	Pass code (system ok)	42	O2 Sensor (rich)
12	Idle Speed (Hi idle fail)	51	ECT voltage high
14	PIP signal unsteady	52	Power Steering Switch
15	KAM/ROM data loss	53	TPS voltage high
16	Idle Speed RPM (low)	54	ACT voltage high
19	Internal ECM volts low	61	ECT voltage low
21	ECT out of range	63	TPS voltage low
22	MAP sensor	64	ACT voltage low
23	TPS	67	A/Con NDS fault
24	ACT Sensor	85	Cannister Purge fault
41	O2 Sensor (lean)	87	Fuel Pump Cct fault

Fig.6: The MPI codes are listed above. When faultfinding, the codes act as a guide only because a rich O2 signal may be the result of a faulty MAP sensor or high fuel pressure.

enquiries only to Injectronics, please.

Fault codes

As mentioned earlier, fault codes are stored in ECM memory and can be retreived by shorting the Self Test Input (STI) to earth and connecting an LED tester between the positive terminal of the battery and the Self Test Output (STO) terminal. The diagnostic connector is located in the engine bay near the brake master cylinder (see Fig.5).

The codes can be retrieved in two main modes, key-on-engine-off (KOEO) and engine running.

When performing any diagnostic tests, ensure that the engine is at operating temperature. Also between tests, the ignition key must be switched off for at least 15 seconds.

The codes flash in a timed sequence order. There is fast data, which includes ECM ID and fault codes which can be decoded by smart data readers ($$$), and then there are the slow codes — which can be read with an LED and 1kΩ resistor!

The codes are presented as a series of 0.5-second pulses, with two seconds between digits and four seconds between service codes. The codes and their description are listed in Fig.6.

Once you have read the codes on a Ford a couple of times, it becomes less daunting. But remember to ensure that the mechanical, air and fuel systems are in good order, because the ECM has no fault codes to indicate problems in these areas.

That's it for another month. Until next time, bye! ❖

THE SERVICEMAN

(Continued from page 45)

Every care has been taken with the preparation of this index, but no responsibility can be accepted for errors or omissions. ❖

Circuit & Design Ideas

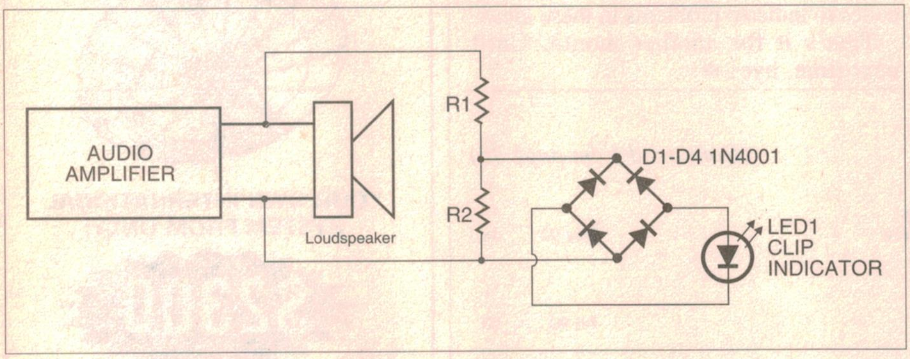
Interesting circuit ideas from readers and technical literature. While this material has been checked as far as possible for feasibility, the circuits have not been built and tested by us. We therefore cannot accept responsibility, enter into correspondence or provide any further information.

Clipping indicator for hifi amps

This simple circuit will let you know if you are overloading your amplifier, causing it to clip the signal — which can cause serious damage to the loudspeakers. R1 and R2 form a resistive divider that is designed to provide a voltage sufficient to light LED1 as the amp's output level becomes too high. D1 to D4 rectify this voltage, which lights LED1 as soon as the input voltage is high enough.

I found that suitable values for R1 were as follows: 1.2k for a 15W amp, 1.8k for 30W, 2.2k for 75W, 2.7k for 100W, and 3.9k for 200W. To calculate the value for R2, find the peak voltage of the amp just before clipping and subtract the voltage drop across the diode bridge. The formula to use is: (√(power x speaker impedance)/0.707)-(voltage drop of D1+D4+LED1) = clipping voltage. For a 75W amp with an 8 ohm speaker, this equals 35V - 2.9V = 32.1V. This is the voltage across R1 at clipping. R2 then equals: (voltage drop across R2/voltage drop across R1) x R1 = (2.9V/32.1V) x 2.2k = 198 ohms. Add 10% to ensure that the LED just flashes on peaks before clipping, so R2 + 10% = 220 ohms.

D. Francis,
Cannonvale QLD $20



Auto arming ignition killer

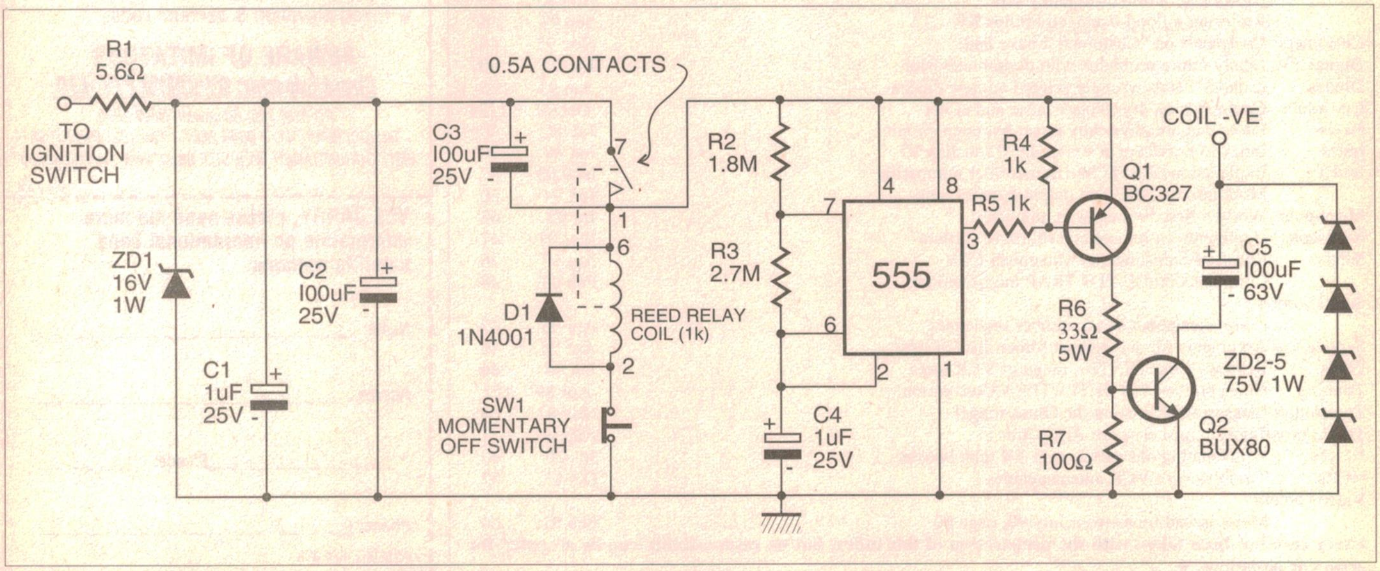
After building a few versions of the 555 timer based ignition killers, I thought I would add another variant. This circuit is auto arming (so you don't forget to turn it on), low in current drain, which helps if a thief leaves the ignition on, as well as being cheap to build. I have installed the circuit in several cars, with no problems.

The circuit is based on a 555 timer IC with R2, R3 and C4 configuring it as an astable multivibrator. The output of IC1 (pin 3) starts in the high (off) state for around three seconds, allowing the thief to get started. Then the timer switches low (on), turning on transistors Q1 and Q2 for 1.8 seconds, which connects the 100uF capacitor C5 in parallel with the distributor's points/transistor, stalling the car. This cycle repeats until the unit is turned off by the normally closed pushbutton switch SW1.

The auto arming part of the circuit comprises capacitor C3 in parallel with the relay contacts. This supplies the relay coil with a 12V spike when the ignition switch is turned on. This causes the relay coil to pull in and automatically latch the circuit on. If the momentary switch is then pressed, the coil current is broken and the coil releases the contacts, turning the circuit off.

Supply filtering is provided by R1, zener diode ZD1, C1 and C2 to prevent voltage spikes rearming the circuit while you're driving along. ZD2 - 5 protect transistor Q2 from high voltage ignition coil spikes if a high tension lead comes off while the car is running.

Anthony Doyle,
Heathridge WA $45



Turn indicator warning device

I developed this circuit to provide a 'hard to ignore' audible alarm that sounds if the turning indicator on a car is left on for more than 10-15 seconds after the car's brakes have been released. When the footbrake is applied while the blinker is on (i.e., waiting in traffic to turn), the alarm is disabled. Once the brake is released, the circuit waits long enough for the car to complete the turn and for the signal to cancel. If it doesn't cancel (because the wheel hasn't turned far enough to engage the canceling mechanism, perhaps due to changing lanes on a highway), the alarm cuts in, sounding in time with the blinkers to remind you to turn them off.

Circuit operation is quite straightfoward, with IC1a and b forming an audio frequency oscillator which is gated on by the turn indicator signal on pin 6. The oscillator's frequency can be tuned to the resonant frequency of the transducer by varying the value of R2, providing maximum volume output.

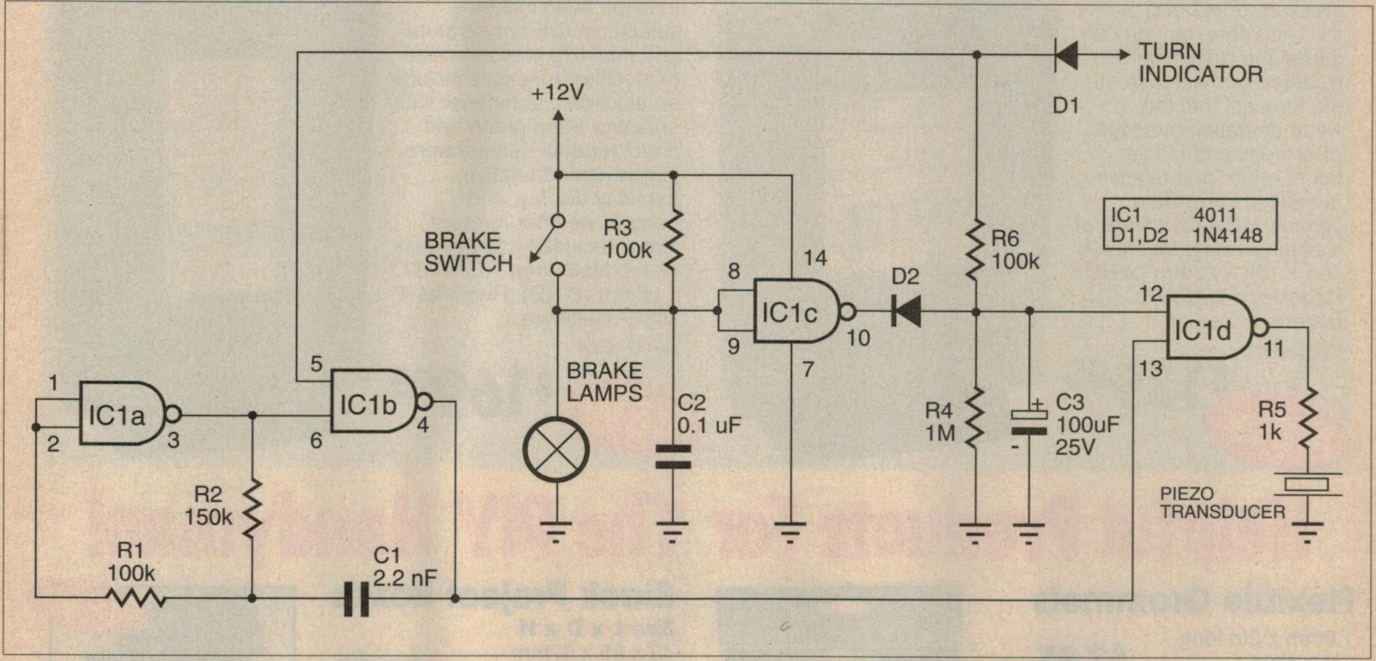
The oscillator's output is fed into one input of IC1d, which drives the piezo transducer via R5. This audio output is in turn gated on or off by the RC network R6 and C3 which is charged up by diode D1 on each positive transition of the indicator output. The time delay of this network is around 10 to 15 seconds, depending on the duty cycle of the car's indicators.

If the foot brake is on, IC1c's output will be low and C3 will be discharged through D2. When you take your foot off the brake, however, the input of IC1c is held low (through the brake lamp itself), and its output swings high. This high is blocked by D2, and C3 is now allowed to charge — eventually allowing the alarm to sound unless the footbrake is reapplied, which effectively resets the delay.

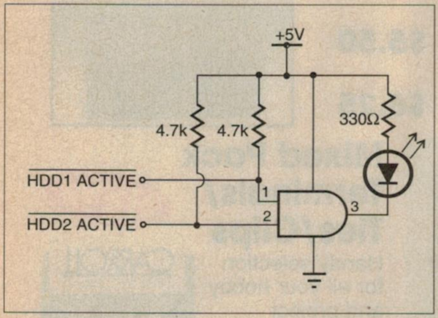
A side benefit of monitoring the brake circuit is that if the brake light switch fails, the alarm will sound irrespective of whether the pedal is pressed or not, and if the brake lights burn out the alarm will come on immediately the indicator is turned on.

The circuit can be mounted in a small plastic box under the dash and is very easy to install, requiring only three connections to the car's existing wiring.

J. Walsh,
East Ryde NSW **$50**



One LED for two drives



Recently I added a second hard drive to my IBM compatible computer. The original hard drive configuration was a single drive with the 'HDD' activity LED being controlled directly from the multi-function I/O card. When the second drive was added, the LED would light only when the master drive was active, but not when the slave drive was in use.

After examining the controller card for any jumpers that would allow the I/O card to flash the LED when either drive was active, and finding none, I constructed this simple circuit.

Both the I/O card and the slave drive had LED connectors, and each had one pin that remained high during disk activity while the other was pulsed low to flash the LED. This circuit simply uses these two active low signals to flash the one LED. The result is that the 'HDD' LED now flashes whenever either hard drive is active.

The circuit was constructed on a small piece of matrix board, and power was supplied from a spare drive power cable dangling in the case.

J. Simons,
Palmyra WA **$20** ❖

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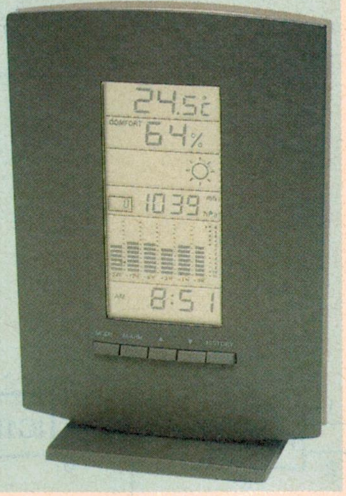

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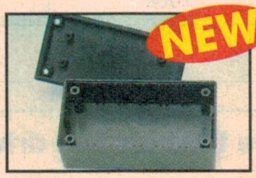

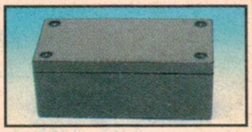

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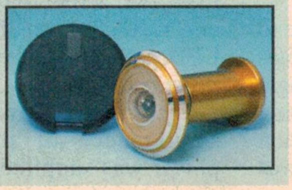

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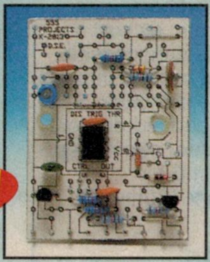

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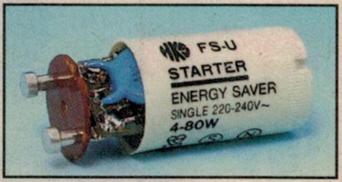

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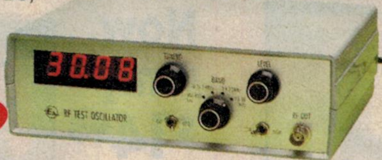

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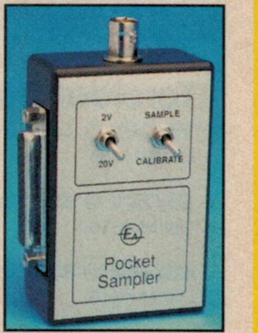

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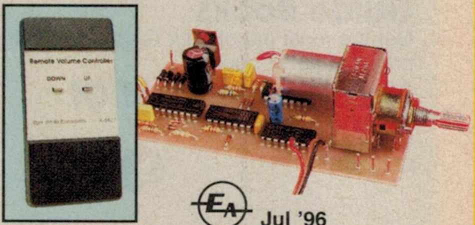

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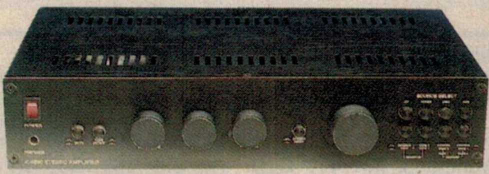

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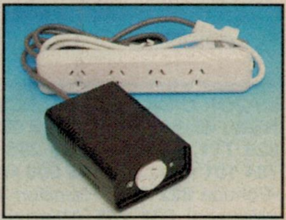

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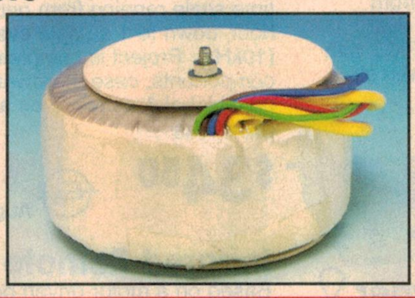

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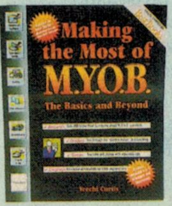

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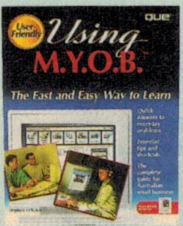

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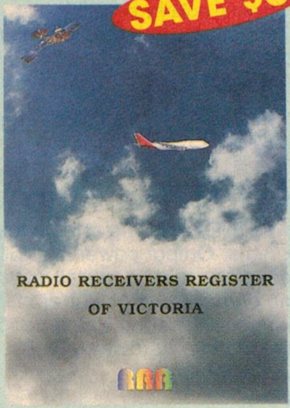

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by GRAHAM CATTLEY

If you have ever wanted to use your computer to log voltage measurements, particularly over an extended period of time, your first thought might be to use one of the fancier multimeters sporting an RS-232C computer interface. This is all very well, but the cost of such a setup can be a bit over the top if you just want to log the charging voltage of a NiCad battery pack overnight, or monitor the temperature of your refrigerator over a 24 hour period.

With this sort of need in mind, we set about designing the Pocket Sampler — a small, low cost data logger/sampler that connects to your computer via the parallel port, giving readings with 8-bit resolution over a 0-2V or 0-20V sampling range. With the software supplied, samples can be taken on a time scale ranging from once every hour, down to about one sample every 100us (10kHz).

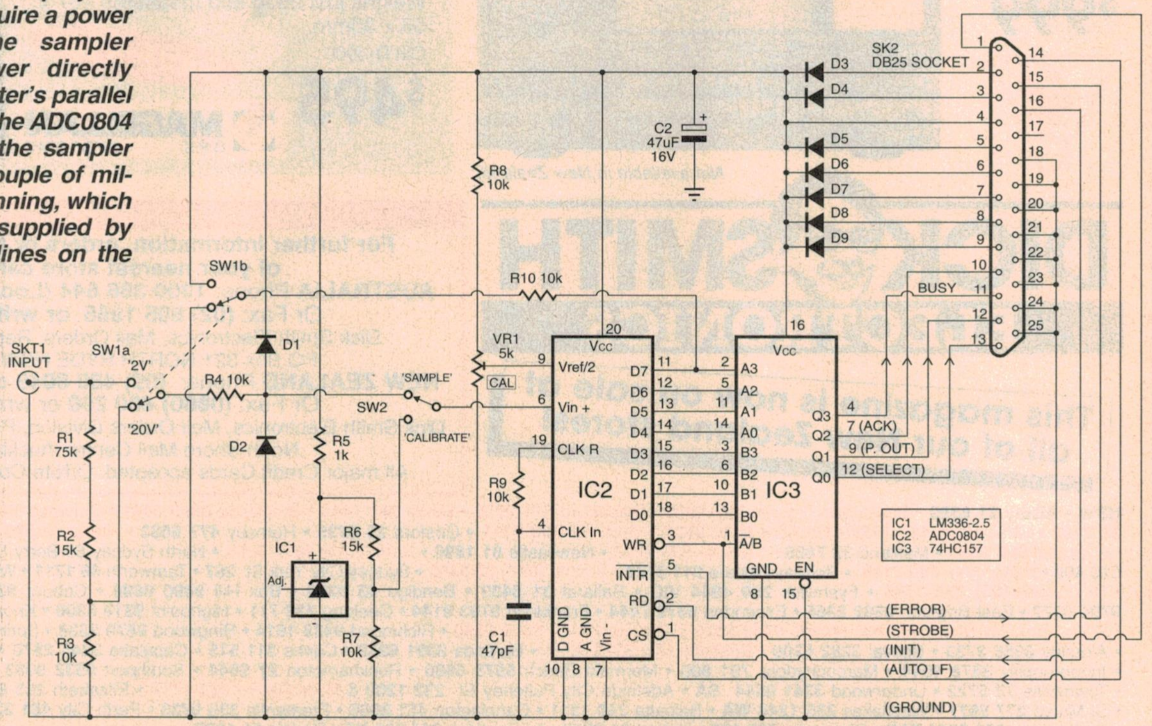
The fact that it will sample this rapidly also means that the Pocket Sampler can be used as a simple low frequency digital scope, to examine audio and other signals up to about 5kHz.

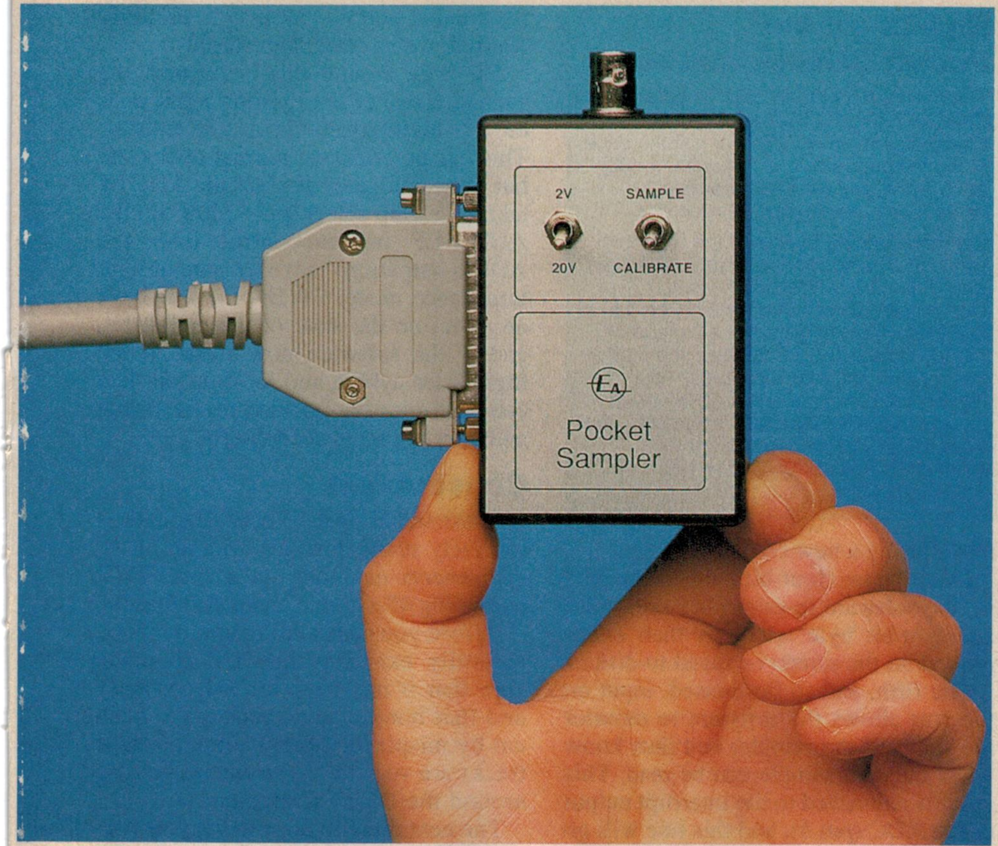
Another handy feature of the Pocket Sampler is that it has been designed to be powered by the computer's parallel port itself, eliminating the need for batteries, plugpacks or power cables. This means that the sampler is always ready for use, whatever the occasion, without your having to hunt around for a fresh battery.

The driver software that controls the sampler caters for just about any application, from a month-long data logging operation, through to audio sampling. The incoming data can be plotted on screen, and can also be saved on disk to be later imported into your favourite spreadsheet or other software.

As the software will run on almost any PC, you can now leave an old XT to log

This is one of the projects that doesn't require a power supply, as the sampler draws its power directly from the computer's parallel port. Based on the ADC0804 A/D converter, the sampler draws only a couple of milliamps when running, which can easily be supplied by the eight data lines on the port.





your data, while you use your 'real' computer for more interesting applications.

Circuit description

Looking at the circuit diagram, you can see that the main analog to digital conversion is performed by IC2, a low cost ADC0804 analog to digital converter. This IC is very useful, as it can perform an eight-bit digital to analog conversion in less than 100us whilst maintaining one-bit accuracy. (It can also run at higher speeds — even up to 25kHz (40us conversion time) — however you suffer a corresponding loss of resolution.)

The ADC0804's sampling rate is determined by the frequency of its internal clock, as it takes 64 clock cycles to perform one eight-bit conversion. From these figures, it is easy to see that in order to obtain a 10kHz sampling rate, we will need a clock frequency of 64 x 10kHz, or 640kHz.

The values of 10k and 47pF, for R9 and C1 respectively, set the chip's internal clock to around 750kHz — a little faster than necessary in order to allow for component tolerance.

All of the ADC08xx series of A/D converters perform an 8-bit conversion on the voltage between their two Vin inputs (Vin+ and Vin-), and it's this *differential* voltage that is finally converted. In this circuit, we are tying the Vin- input to ground and using Vin+ as the main input, effectively giving the converter a 'ground reference'.

While Vin+ could be connected directly to the input socket on the box, it is sensible to provide a degree of input conditioning, just to be on the safe side. This is performed by the two catcher diodes D1 and D2, along with R4 which limits the input current to the IC.

The resistor divider network comprising R1, R2 and R3, along with SW1a, allow for an input voltage division of ten, giving the sampler a full scale reading of 2V or 20V, depending on the position of SW1. Sw1b provides the computer with feedback on the switch position so that the appropriate scale can be displayed by the computer.

Self powered

As mentioned earlier, the Pocket Sampler runs off power supplied by the parallel port — this is done by setting all of the eight data bits on the port high, and then using this 'combined high' to power the sampler (we can get away with this as the sampler only draws a couple of milliamps). Diodes D3 to D9 are included as a safety precaution, in case all of the data bits were not set high when the sampler was first plugged in.

This system of 'stealing' power from the port certainly has its advantages, but it also comes with a major disadvantage, in that the final supply voltage can vary from computer to computer.

Checking the voltages produced by a variety of different computers of varying vintages, we found that the sampler's supply voltage ranged from 3.20V up to 4.45V on various brands of parallel port (This is more than enough to run the Pocket Sampler, which will operate on voltages as low as 2.5V).

In order for any ADC to operate correctly, it needs to be supplied with a reference voltage with which to compare the input voltage. In the ADC0804 this is achieved by a pair of 16k resistors built in to the chip. These are internally connected between Vref/2 (pin 9) and the chip's power rails, and hold the pin at half the supply voltage.

This works very well if you want the sampler's full scale reading to equal the chip's supply voltage, but in this project the supply voltage can't be guaranteed to be the same from computer to computer. If we were to rely on this built-in half rail reference, we wouldn't know what the full scale voltage was, and thus couldn't scale the readings accordingly.

Instead, we provide our own voltage reference via the 5k trimpot VR1 and the 10k resistor R8. This — along with the chip's two internal 16k resistors — lets you set the voltage at pin 9 to 1.0V volt, giving the ADC a full scale output of 2.0 volts.

Turning now to IC1, you'll see that it is a 2.5V voltage reference supplying the resistive divider made up of R6 and R7. With 2.5V applied to the top of this divider, the junction of these two resistors is held at a relatively stable 1.0V regardless of supply voltage. SW2 switches the ADC's Vin+ input between either the sampler's input signal or this 1.0V reference.

This voltage reference lets you initially calibrate the sampler, and also check the calibration at any time, particularly if you're using the sampler on a different computer.

Good question!

Having said that, the question that no doubt springs to mind is: If you can supply a 1V reference voltage to SW2, why don't you just feed it in to pin 9 and let the ADC use it as its reference, instead of using the trimpot?

It's a good question, with an equally good answer: The 16k resistors connected to this pin inside the ADC tend to drag the pin's DC level towards the positive supply rail. Of course a low impedance one volt reference applied to this pin would solve the problem, but this would mean another IC on the board, and a corresponding increase in cost,

size and circuit complexity.

With the aim of making this project cheap and simple, we decided to go with the current circuit which only needs recalibrating if the sampler is used on a computer with a different parallel port.

Eight into four

The last aspect of the circuit's operation is based around the fact that the parallel port on a PC only has a five-bit input port, while the ADC0804 chip delivers an eight-bit digital value. If we want to transfer an eight-bit value back to the computer over five lines, we are obviously going to have to pull a few tricks. As it happens using IC3 we can perform the transfer using only *four* of the input lines, plus one of the port's output control lines.

IC3 is a quad two-input multiplexer, and it is used here to chop the eight-bit value from the ADC into two four-bit values ('nybbles') which are sent along four of the port's inputs separately, one at a time. The software controls the order in which the nybbles are sent, by toggling the STROBE line high and low to receive the low and high halves of the byte respectively.

If you look carefully at the circuit diagram, you'll see that the STROBE line also connects to the WR input on the ADC0804. This input is rising edge triggered, and it is used to trigger the ADC into starting a new sample, so that as soon as the computer has finished reading in the second nybble, the STROBE line swings high, triggering the ADC into starting a new conversion.

Once the two four-bit nybbles are read in, the software re-assembles them into an eight-bit byte which is then either plotted on the screen or saved to disk.

The fifth, and so far unused, input on the port allows the software to monitor the status of the sampler and thus know when the next sample can be read. This input is connected to the interrupt output of the ADC (pin 5), and this line will go high while the sampler is actually performing a conversion. By waiting until this line goes low before reading in the byte, and triggering the sampler to start a new conversion as soon as the byte has been transferred, fully synchronous operation is assured.

I mentioned earlier that SW1b was used to inform the computer as to the voltage scale selected (2V or 20V). This would obviously need to connect to an input on the parallel port — but as you probably realised, we've used them all up!

The way around this is connect the switch to one of the existing input lines on the multiplexer via a 10k resistor. This has no effect on normal operation, but if the computer disables the ADC by taking its chip select (pin 1) low via the AUTO-LF output control line, the ADC's outputs go into a tri-state or high impedance mode. SW1b will *now* have an effect on the state of the eighth bit, and if the software now reads in the high-order nybble and looks at bit 4, it can determine the position of the switch and alter the scale accordingly...

Construction

Construction of the Pocket Sampler is relatively straightforward, with all of the components mounting on a small PCB measuring 45 x 73mm and coded 96ps08.

Before you start adding components, carefully examine the PCB to make sure that it has been etched correctly and that none of the tracks have been cut by misplaced holes. Some of these tracks are very thin — especially those around the DB25 connector.

The next thing to do is to trim the corners off the board, as indicated by the guidelines, so that the board fits easily into the box. At this stage, you might also like to enlarge the holes for the DB25 socket so that a pair of 6BA bolts can be used to secure the board (and socket) in the bottom of the box.

This done, insert the 11 PC terminal pins on the board using a small pair of pliers, and solder them in place. Next are the four links, which can be made from scraps of tinned copper wire (or resistor leads). These should be kept as straight and flat as possible to prevent shorts, as they run quite close to the IC pins.

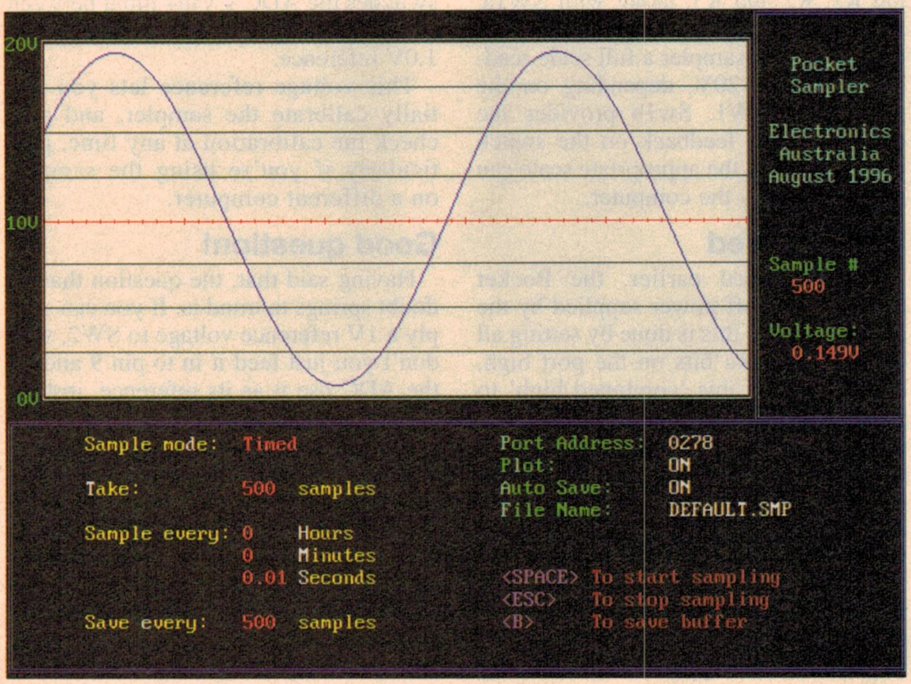
The remaining components can now be installed in almost any order, using the overlay diagram as a guide. (You might leave the DB25 socket until last, as it makes the board a little difficult to handle.) Once everything is on the board, carefully inspect the solder joints around IC2, IC3 and the DB25 connector; several tracks run between the pins on these components and it is easy to accidentally bridge or short out one of these tracks.

Once you are happy with the board, wire up the two switches as shown in the overlay, along with the BNC socket, and

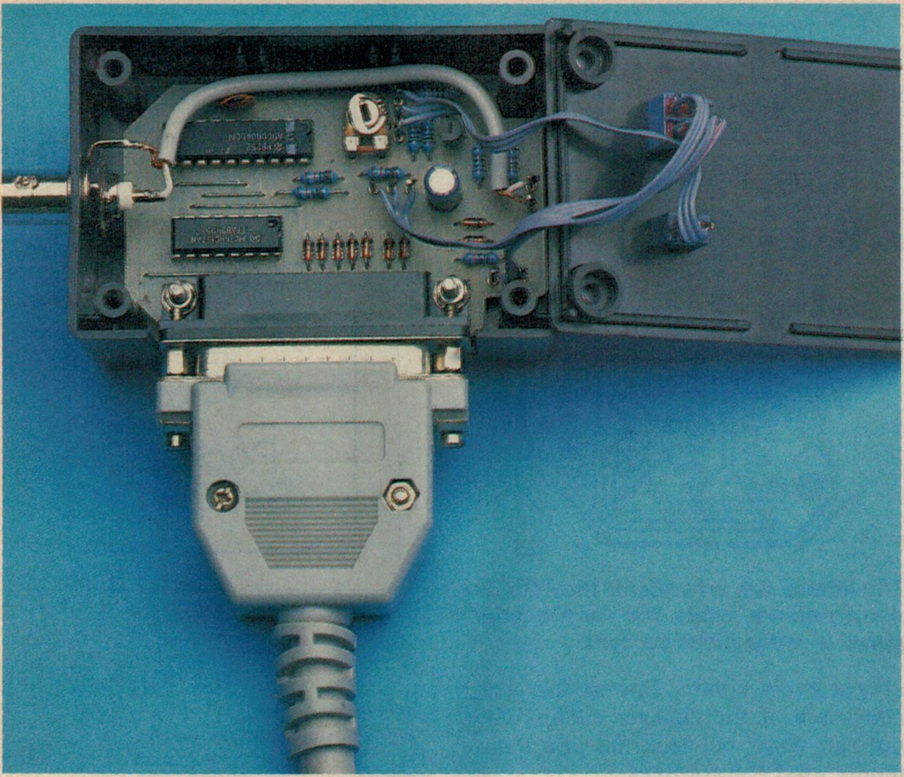
How to get the Pocket Sampler software

The software for the Pocket Sampler (POCKET.EXE) is available from the Electronics Australia BBS for just the price of the telephone call. The number is (02) 9353 0627, and the BBS operates 24 hours a day, seven days a week.

For those unable to access the BBS conveniently, the software is also available by mail through our Reader Services Department, by sending a formatted 3.5" or 5.25" high density disk plus a cheque or money order for $5.00 to cover the cost of the copying and return postage. Your cheque or money order should be made out to Electronics Australia magazine, and mailed with your disk and order to: Electronics Australia, PO Box 199, Alexandria 2015.



This screen shot shows a waveform recorded by the sampler. As you can see, the Pocket Sampler can be configured to take samples from few milliseconds, to once every four days or so.



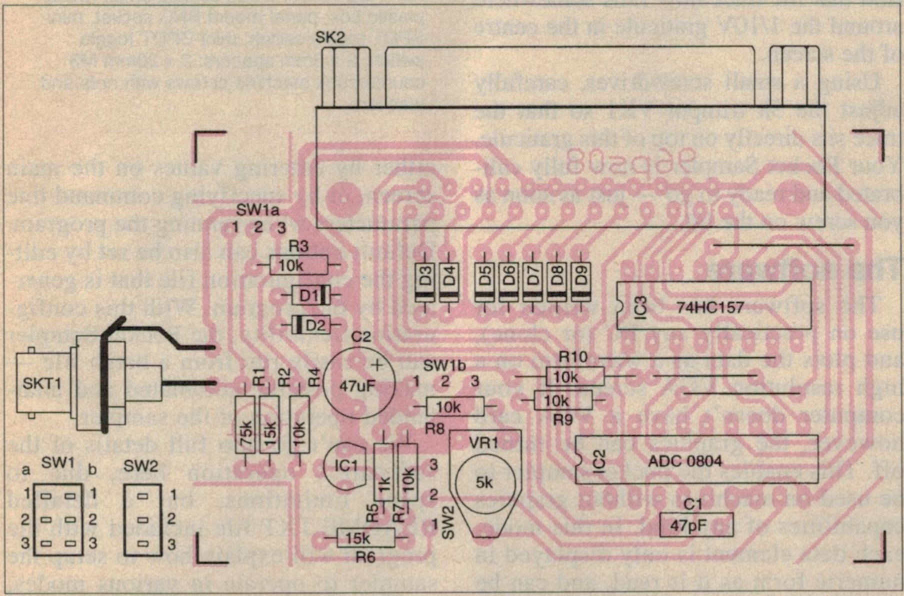
This shot shows how the board is mounted in the box, as well as showing the wiring to the switches and BNC socket.

you can get started on the box.

A slot 53mm wide by 20mm deep needs to be cut in the left hand side of the box in order to accommodate the DB25 socket. You are probably best off using a sharp hobby knife to remove most of the plastic, and finishing it off with a file to give the slot clean, straight edges.

Drill a hole in the top end of the box, 10mm down from the lid to mount the BNC socket, as well as two holes in the lid for the switches. You can use a copy of the front panel artwork as a guide when drilling these last two holes, so that they will line up with the legends on the front panel.

Use a pair of 20mm M3 countersunk bolts and a couple of 6mm spacers to support the PC board 6mm above the bottom of the box, so that the DB25



The overlay diagram above shows the mounting position of all the components on the board. Use a short length of shielded cable to connect the BNC socket, to prevent noise.

socket fits flush inside the cut out; the close-up photo should help you in this final stage of construction. (Note that if you use metal spacers, you should also use a couple of insulating washers to prevent shorts across the trackwork under the board...)

Testing, testing

Once the Pocket Sampler is assembled, plug it into the parallel port of your computer (using a DB25 plug to DB25 plug computer cable) and run the sampling software POCKET.EXE. Assuming the correct parallel port is selected in the software, you should be able to measure something around 3 - 5V DC between the cathodes of diodes D3 to D9 and the body of the BNC connector.

If not, unplug the sampler, and check that you are using the correct parallel port for your computer, as it can vary from machine to machine. If the port address seems to be correct, the problem is probably in the hardware and so there is nothing for it but to take the sampler apart and start checking...

One place to look is the parallel cable itself; the Pocket Sampler uses almost every control line on the port, and some of the cheaper cables may not run wires between the less commonly used control lines.

With any luck though, you will get a voltage reading between the diodes and ground, and so the next thing to check is the voltage on the junction of R6 and R7 (15k and 10k), where they join to one end of SW2. This should measure 1.0V, and is the calibration voltage which can be switched to the ADC input.

All being well, you should now be getting a trace on the screen, although it may be running at the very bottom of the display area. Flip the Sample/Calibrate switch to 'Calibrate', and you should find that the trace now runs somewhere around the 1/10V graticule in the centre of the screen.

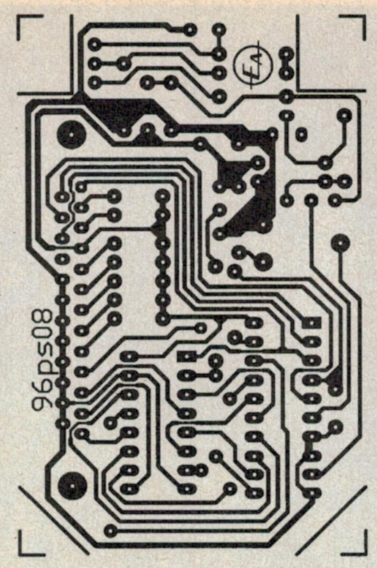
Using a small screwdriver, carefully adjust the 5k trimpot VR1 so that the trace sits directly on top of this graticule. Your Pocket Sampler is now fully calibrated and ready to go — just as soon as you screw on the lid.

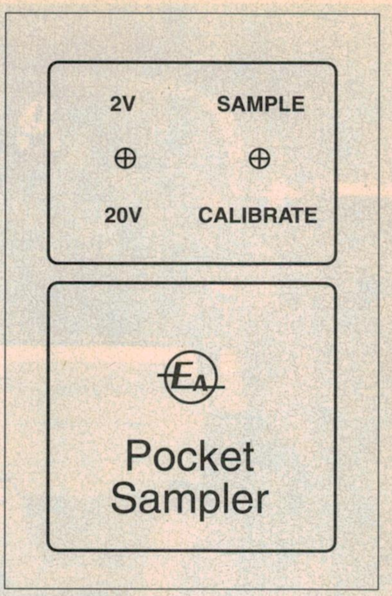
The software

The software has been written for use on practically any PC (or clone), and plots the data as a waveform on a high resolution VGA screen. If your computer doesn't have a VGA card however, the graphics can be turned off. This enables the pocket sampler to be used on machines without graphics capabilities of any kind. In this mode, each data element is only displayed in numeric form as it is read, and can be saved to disk for future reference.

The sampling rate, along with all other sampling options, can be set either by entering values on the main screen, or by specifying command line parameters when running the program. Default options can also be set by editing the configuration file that is generated by the program. With this configuration flexibility, the Pocket Sampler can be easily run from a batch file — making possible automated and unattended operation of the sampler.

We can't go into full details of the software's operation here, due to space limitations, but a detailed README.TXT file included with the program will explain how to setup the sampler to operate in various modes, as well as how to import the saved data into your favorite spreadsheet or other application. ❖





The actual size artwork for the PCB is shown above, while that for the front panel is reproduced at right.

Parts List

Resistors

(all 5% tolerance unless noted)

R1	75k 1% tolerance
R2,R6	15k 1% tolerance
R3,R7	10k 1% tolerance
R4,R8,R9,R10	10k
R5	1k
RV1	5k horiz. mount mini trimpot

Capacitors

C1	47pF disc ceramic
C2	47uF 16VW electrolytic

Semiconductors

D1-9	1N4148 or equiv. diode
IC1	LM336-2.5 voltage reference
IC2	ADC0804 8-bit A/D converter
IC3	74HC157 quad 2-input multiplexer

Miscellaneous

PC board 47 x 73mm, coded 96ps08; 25-pin R/A PCB mount DB25 socket; small (UB5) plastic box; panel mount BNC socket, mini SPDT toggle switch; mini DPDT toggle switch; 2 x 6mm spacers; 2 x 20mm M3 countersunk machine screws with nuts and washers.

NEW KITS FOR EA PROJECTS

FROM DICK SMITH ELECTRONICS:

Pocket Sampler (August 1996): The DSE kit is complete with all electronic components as described, pre-punched plastic box, front panel label and the author's software on 3.5" floppy disk. Cat. number K-7345, it is priced at $34.50.

FROM JAYCAR ELECTRONICS:

Pocket Sampler (August 1996): The Jaycar kit is complete with all electronic components as described, and plastic box with silk-screen front panel. Cat. number KA-1787, it is priced at $29.95.

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NEW BOOKS

Upgrading PCs

THE COMPLETE PC UPGRADE & MAINTENANCE GUIDE, Fourth Edition, by Mark Minasi. Published by Sybex Inc. Soft covers, 229 x 190mm, 1246 pages, with CD-ROM. ISBN 0-7821-1660-4. RRP $85.

It's now about 15 years since the first IBM PC appeared, and in that time a huge number of developments have taken place in PC hardware alone. Small wonder that most of us can't keep track of it all, and need reference books beside us whenever we have to either upgrade or repair our machines. Books that need to be constantly updated and revised, to keep up with developments...

Mark Minasi is a well-known US lecturer and writer on this subject, and his seminars and instructional videos are very popular. This is the updated and revised fourth edition of his book on PC upgrading and maintenance, and has now grown to a massive 1246 pages, and is accompanied by a CD-ROM with clips taken from his videos.

Even more so than with the previous editions, it covers just about every conceivable aspect of PC hardware operation, upgrading and maintenance — from power supplies to CPUs, disk drives, video cards, SCSI controllers, sound cards, CD-ROM drives and so on. In fact there's now even a chapter on laser printers, as they're so widely used.

The 'nitty gritty' technical data provided may not be quite as deep or as comprehensive as some similar books, but on the other hand the general clarity and readability level is particularly high. If you don't need to sort out the *really* nasty problems, it would make a good choice. The video clips on the CD-ROM are quite helpful at a general introductory level, too.

The review copy came from Addison Wesley Longman Australia, of PO Box 1024, South Melbourne 3205; phone (03) 9697 0666. (J.R.)

Alarm systems

ELECTRONIC ALARM AND SECURITY SYSTEMS: A Technician's Guide, by Delton T. Horn. Published by TAB Books. Hard cover, 195 x 242mm, 256 pages. ISBN 0-07-030528-5. RRP $79.95.

This book covers the basic principles of designing, installing and maintaining home alarm systems, and is aimed at those with a knowledge of electronics who want to get into this field. It therefore also suits trained installers keen to expand their knowledge. It does not cover large industrial or commercial alarm system installation.

The first chapter briefly explains the basic principles of any alarm system and looks at the most common types of alarm sensors. The next two chapters discuss planning issues and how to save time and money in an alarm system installation. The actual installation is described in Chapter 4, and following chapters look at expanding the system to give an alarm in case of fire, gas leaks and flooding.

Maintenance is described in Chapter 8, and troubleshooting and repair is presented in Chapter 9. The final chapter looks at recent developments in security systems, and describes how these can be used to advantage in a home alarm system. Topics include lasers and the advantages and disadvantages of computer-based alarm systems.

It has a lot of diagrams and concentrates on practical issues, such as external door construction, how a door should be hung, and the best type of lock to use. The technical level will suit anyone with a basic knowledge of electronics, including hobbyists.

The review copy came from McGraw-Hill Australia, at PO Box 239, Roseville 2069; phone (02) 417 4288. (P.P.)

Servicing guide

McGRAW-HILL ELECTRONIC TROUBLESHOOTING HANDBOOK, by John D. Lenk. Published by McGraw-Hill, 1995. Hard covers, 243 x 191mm, 372 pages. ISBN 0-07-037658-1. RRP $94.95.

As author John Lenk says in his introduction, the aim of this book is to fill the gap between electronics theory and the practical 'how to' of troublshooting. It's intended for trainee service technicians, working techs and field service engineers (to brush up their skills), and also hobbyists with a reasonable level of knowledge about circuits and test instruments, who would like to be better at troubleshooting domestic equipment.

John Lenk is of course a well known and very successful US technical writer, with many books and articles to his credit. This is apparently his 82nd book — quite an achievement!

Almost the first third of the book is an introductory chapter on basic troubleshooting techniques and procedures. Then there are chapters dealing specifically with troubleshooting TVs, VCRs, camcorders, CD and DAT machines, digital circuits and finally communications equipment (receivers, transmitters etc.).

Overall the treatment is both practical and up to date, giving a lot of information on basic troubleshooting of modern equipment. As a result it would be almost as much use on this side of the world as in the USA — unlike many other books of this type. There's very little reference to specific brands or models, and most of the discussion is at the block diagram or generic circuit level.

Despite its fairly hefty price it should be quite a worthwhile reference, for anyone wanting a guide to modern circuit troubleshooting.

The review copy came from McGraw-Hill Australia, at PO Box 239, Roseville 2069; phone (02) 417 4288. (J.R.) ❖

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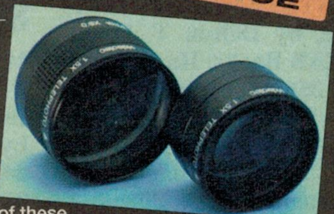

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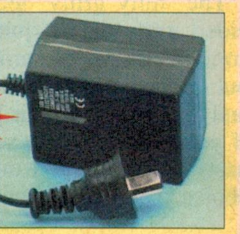

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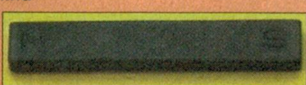

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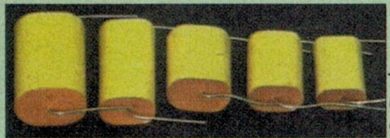

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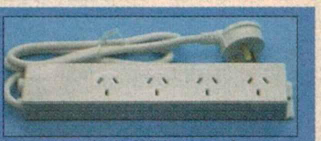

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Long lock output	√	√
Flash parking lights	√	√
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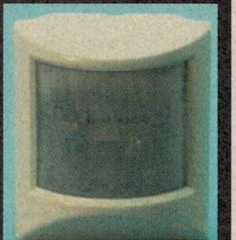

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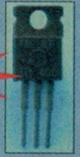

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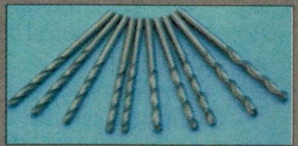

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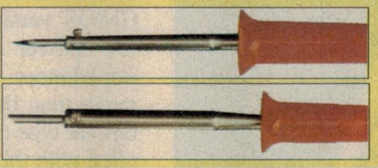

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DSE 'Discovery Series' Construction Project:

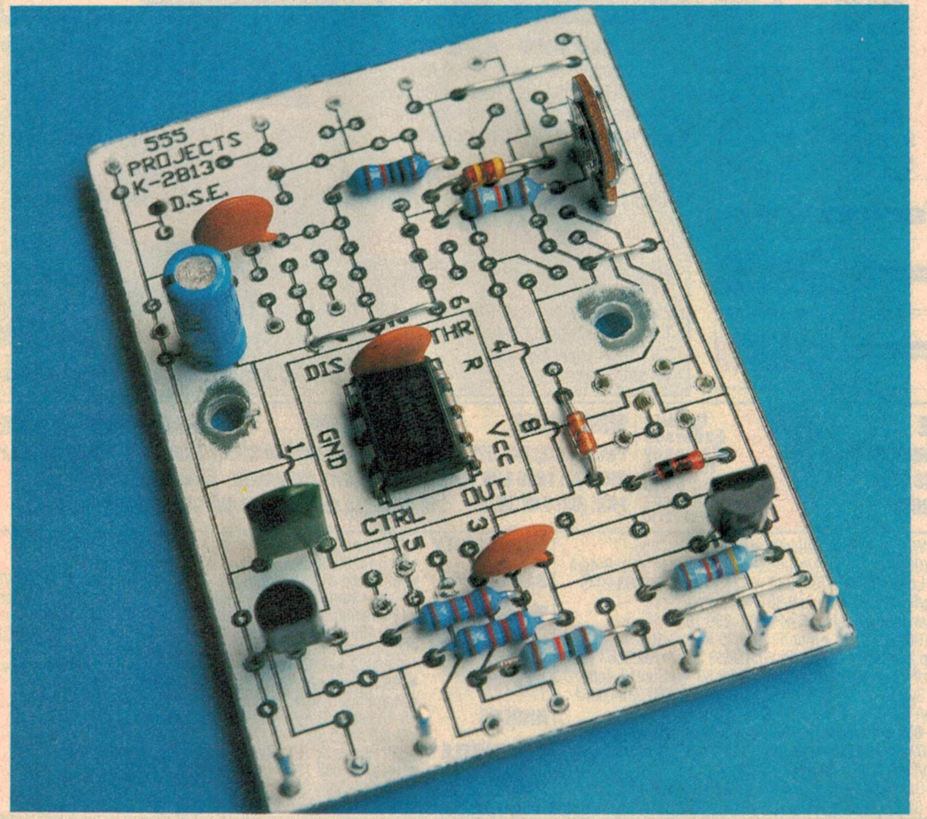
A MULTIPURPOSE MODULE USING THE 555

When Signetics developed the humble 555 timer chip back in the early 1970s, they probably didn't realise the enormous number of applications for it that electronics people would dream up. Whole books have been written on 555-based circuits, and now Dick Smith Electronics has produced a multipurpose 555 kit module as part of its popular Discovery Series of learning kits. The kit is available from DSE's stores as Cat. No. K-2813, priced at only $16.95.

The 555 is a general purpose IC that acts as a building block for timer projects, just as the op-amp is a building block for amplifiers. It was first introduced as the NE555 by the Signetics Corporation in 1972, and has since been copied by many other manufacturers. It has been a great success in providing a compact, precise and cost effective solution to a large proportion of timer designs.

Having a few 555's on hand at the electronics bench allows a timer or pulse generator to be quickly and cheaply put together with just a few parts. Unlike many other chips it is capable of operating relays directly, and it can be easily cascaded or connected to digital circuitry for extended or complex timing. It was the versatility and popularity of the 555 which prompted the R&D department of DSE to develop this project kit, to make it even easier to set up those utility projects, as well as for use as a 555 demonstrator.

In the manual that comes with the K-2813 kit, almost 30 different 555 circuits are described, any of which can be constructed on the one specially designed PCB provided. Component layout diagrams are provided for each circuit, and the track layout has also been sketched on the component side of the PCB to make it easier to create your own circuits. Formulas and waveforms are also provided for most of the projects, to allow the circuits to be easily tailored to the application. Because of the similarity of some of the circuits they are not all fully described.



The 555 supplied with the kit has a supply voltage range of 4.5V to 16V, but the particular circuit configuration used will ultimately determine the supply voltage required. The PCB can be fitted neatly into a low cost 'zippy' box (DSE Cat. No. H-2855) if required. No power supply or box are supplied with the kit.

Because of the comprehensive nature of the kit manual, we're not proposing to duplicate it here. What we'll do instead is provide the material introducing the 555 chip and its operation, and then sample some of the more interesting circuits you can build around it. For the full details you can refer to the DSE kit manual itself.

Inside the 555

Fig.1 is a functional illustration of the circuitry inside the 555. Table 1 shows the functions of the device, while the electrical specifications of three common brands of 555 are listed in Table 2. The TLC555 is a CMOS version of the 555 that features low power consumption, higher input impedances and wider supply voltage range than the original bipolar type. The bipolar type (LM555, NE555, etc), as supplied with this kit, features a higher output current capability. Both types are functionally equivalent.

Note that there has been one type of 555, the KA555, that does not conform exactly to Table 2 and can cause incorrect circuit operation in some of the configurations. This type is not being supplied with the DSE kit.

Power to the IC is connected between Vcc (pin 8) and Ground (pin 1). A resistor voltage divider with three equal-value resistors 'R' is connected internally across the supply pins as shown. This provides a voltage reference of 2Vcc/3 at the inverting (-) input of voltage comparator 1

TABLE 1

FUNCTION TABLE

RESET VOLTAGE	TRIGGER VOLTAGE	THRESHOLD VOLTAGE	OUTPUT	DISCHARGE SWITCH
LOW	IRRELEVANT	IRRELEVANT	LOW	ON
HIGH	< Vcc/3	IRRELEVANT	HIGH	OFF
HIGH	> Vcc/3	> 2Vcc/3	LOW	ON
HIGH	> Vcc/3	< 2Vcc/3	SAME AS PREVIOUS STATE	

NOTE- WHEN THE CONTROL VOLTAGE (Vc) IS ALTERED, REPLACE Vcc/3 IN THE ABOVE TABLE WITH Vc/2.

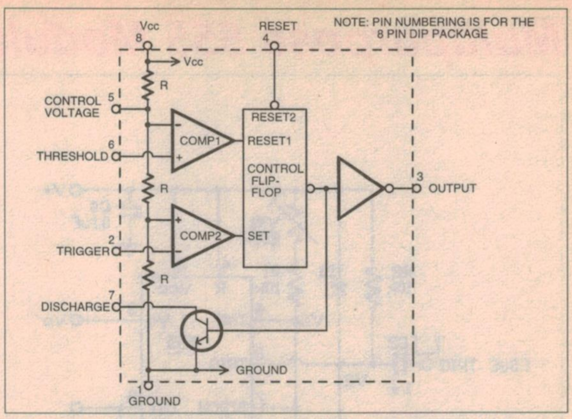


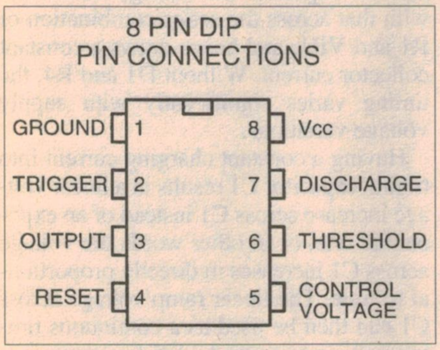
Fig.1: Inside the 555. One of the two comparators can reset the flipflop, while the other can set it.

TABLE 2

SPECIFICATIONS
Vcc = 15V unless otherwise stated / Ta = 25 deg C

		LM/NE555C (bipolar)				TLC555C (CMOS)		
Parameters	Conditions	Min	Typ	Max	Conditions	Min	Typ	Max
Supply Voltage		4.5V		16V		2V		18V
Supply Current	(no load, Vo = low)		10mA	15mA			360uA	
Power Dissipation				600mW				600mW
Threshold Voltage	(% of Vcc)		67%		(% of Vcc)		67%	
Threshold Current			0.1uA	0.25uA	(Vcc = 5V)		10pA	
Trigger Voltage	(% of Vcc)		33%		(% of Vcc)		33%	
Trigger Current			0.5uA		(Vcc = 5V)		10pA	
Reset Voltage			0.4V	1V		0.4V	1.1V	1.5V
Reset Current			0.1mA	0.4mA	(Vcc = 5V)		10pA	
High Level Output	(Isource = 100mA)		13.3V		(Isource = 10mA)	12.5V	14.2V	
Low Level Output	(Isink = 100mA)		2V	2.5V	(Isink = 100mA)		1.28V	3.2V
Output Current	Sink			200mA			100mA	
	Source			200mA			10mA	
Initial Error of Timing Interval			1%				1%	

Fig.2 (below): The pin connections for the most common type of 555, in an 8-pin DIL package.



(COMP1), and a voltage reference of Vcc/3 at the noninverting (+) input of comparator 2. These reference voltages can be varied by changing the voltage at the Control Voltage (pin 5) input. The value of R is typically about 5k ohms for the bipolar 555's and about 75k ohms for the CMOS types.

Comparator 1 generates a reset signal for the control flip-flop whenever the Threshold (pin 6) voltage exceeds 2Vcc/3, and comparator 2 generates a set signal whenever the Trigger (pin 2) voltage falls below Vcc/3. The flip-flop can also be forcibly reset under any condition by applying 0V to Reset (pin 4).

The flip-flop output passes through a buffer before appearing at the final Output (pin 3). It also controls a discharge transistor switch connected between Discharge (pin 7) and Ground (pin 1). The discharge transistor is on (conducting) whenever the Output (pin 3) is at 0V.

So that's the basic 555 chip and how it works. We're now going to look at some of the interesting ways in which it can be used.

In the DSE kit manual, the circuits have been divided into three sections. Circuits 1 to 9 are for monostable multivibrators, also called 'one shots'. The function of these circuits is to produce a single timed output pulse, either high or low depending on the particular circuit, when an external trigger pulse is applied.

Circuits 10 to 16 cover astable multivibrators, which generate a continuous pulse stream with a timed period and duty cycle.

Circuits 17 to 26 are miscellaneous circuits including flip-flops, Schmitt triggers, voltage converters and others. Finally circuits 27 to 41 show various input/output options that are applicable to most of the projects.

Basic one-shot

Shown here in Fig.3, this is one of the most basic operating modes for the 555. Its output is normally 0V and generates a positive output pulse when the trigger input of the 555 is pulled below Vcc/3, by means of a trigger pulse applied via C2 (edge trigger) or directly.

One shortcoming of this circuit which may be important in some applications is that we don't know what is going to happen at the output when power is first applied. At power-up, capacitor C1 is discharged, making the Threshold input 0V, and the Trigger input is at Vcc. Looking at Table 1, these input conditions leave the output in its previous state. But because there is no defined previous state, the output may start as 0V or it may produce a pulse.

A power-on reset circuit can be used to ensure that the output starts at 0V, and a suitable circuit shown in the kit manual.

While the Output is 0V, the Discharge transistor switch is on and keeps C1 discharged. Applying a negative-going pulse at the trigger input causes the Output to go high and the Discharge switch turns off, allowing C1 to charge. Provided the Trigger input of the 555 is then returned to its high state, the Threshold voltage eventually reaches 2Vcc/3 — causing the Output to go low and the Discharge transistor to switch on, returning the circuit to its stable state ready for another trigger pulse.

If the trigger pulse is narrower than the output pulse then components C2, R2 and D1 can be omitted.

If the 555 Trigger input remains low after the output period then the output will remain high until the Trigger goes high again.

The width of the pulse produced is defined as R1xC1xLn(3), which is

Multipurpose 555 Module

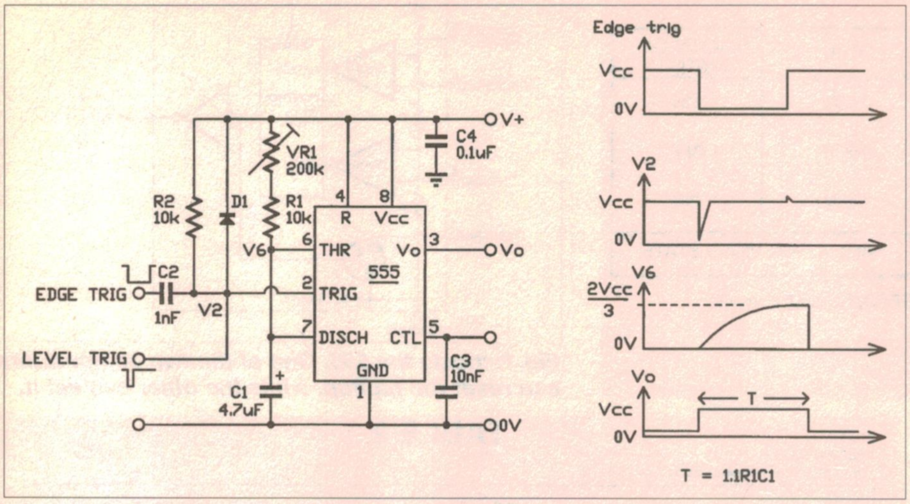


Fig.3: The 555 used as monostable or 'one shot'. The waveforms show how it operates when triggered.

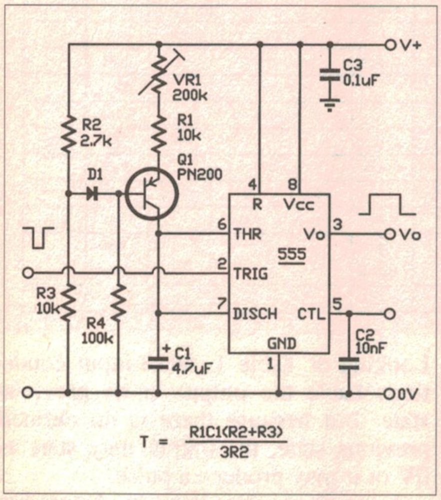


Fig.4: By adding a resistor conected as a 'constant current source', the monostable can generate a linear ramp.

approximately equal to 1.1R1C1, and is the time it takes a capacitor to charge to 2/3 of the charging voltage, or to discharge to 1/3 of its initial voltage.

For long time periods, the maximum value of R1 that can be used is determined by the amount of current flowing out of the Threshold terminal — and also by the leakage resistance of capacitor C1. Typical maximum values are 10M when Vcc is 15V and 3M when Vcc is 5V, but lower values result in better accuracy. The minimum value of R1 is determined by power consumption considerations and is usually in the order of 1kΩ.

The maximum value that can be used for C1 is limited by its leakage current, which is generally higher for larger values of capacitance. A typical limit might be 100uF for standard electrolytics or 1000uF for low leakage types, depending on the accuracy required. The minimum value of C1 is usually about 100pF, to swamp the effect of other circuit capacitances.

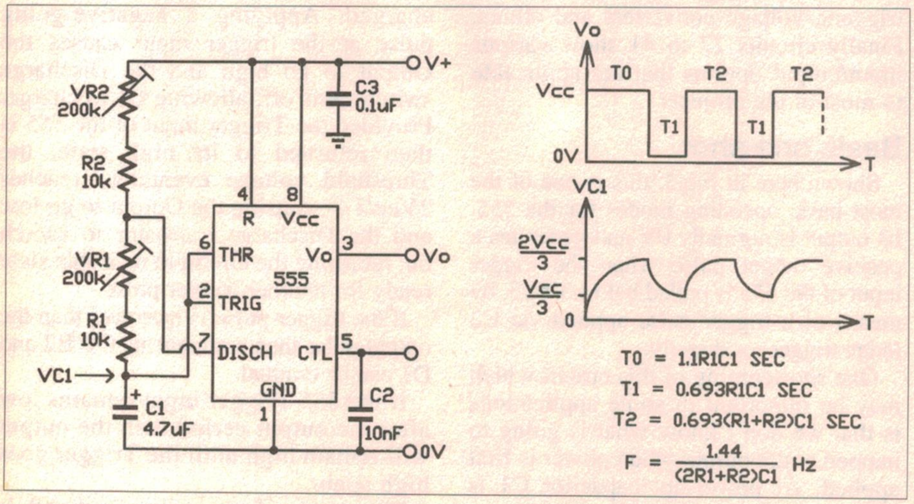


Fig.5: The basic circuit used to operate the 555 as an astable or free-running oscillator, together with its design equations and waveforms.

For this circuit and all the others, the Control input is bypassed by capacitor C3 to improve the noise immunity, because the Control input is also a comparator input. Capacitor C4 is used to suppress the voltage spikes that appear on the supply line when the output of the 555 changes state, and should always be used to prevent instability or erratic timing. This applies especially to the bipolar types of 555.

Linear ramp mono

In this circuit (Fig.4), instead of simply having a resistor path to charge C1, a constant current source is used. Resistors R2 and R3 provide a fixed reference voltage, while D1 provides temperature compensation to match that of transistor Q1's base-emitter junction. The nett result is that Q1 acts to duplicate the voltage across R2 with that across the series combination of R1 and VR1, and hence draws a constant collector current. Without D1 and R4, the timing varies significantly with supply voltage variations.

Having a constant charging current into timing capacitor C1 results in a linear voltage increase across C1 instead of an exponential one, or in other words the voltage across C1 increases in directly proportional to time. The linear ramp voltage across C1 can then be used as a continuous timing voltage to control other functions.

Basic astable

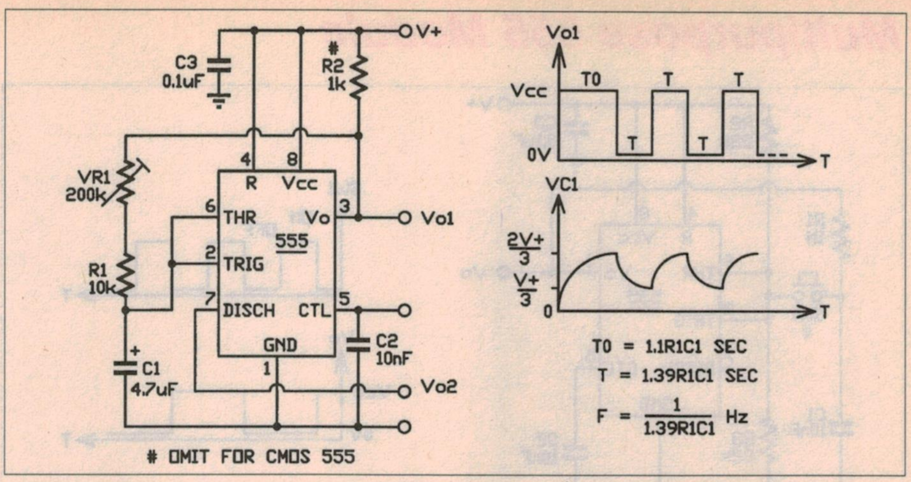
Fig.5 shows what is probably the most common 555 astable or 'free running' configuration. When power is first applied, C1 has no charge and so the Threshold and Trigger inputs are at 0V. Table 1 shows that the Output will then be high, and the Discharge transistor will be off, allowing C1 to charge via R1, VR1, R2 and VR2. When the Threshold voltage rises to 2Vcc/3 the Output goes low and capacitor C1 discharges toward 0V through R1 and VR1.

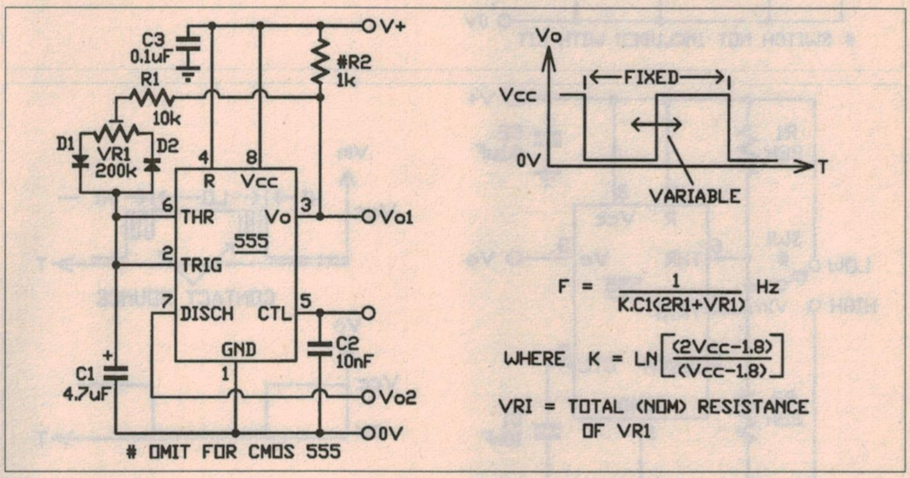
When the Trigger voltage falls to Vcc/3 the Output goes high again and the cycle is repeated.

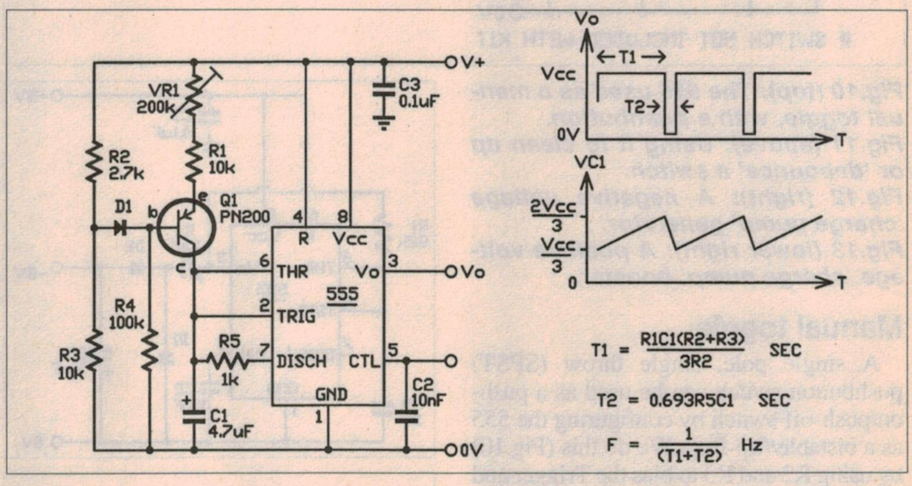
Because the discharge path has less resistance than the charge path, the output duty cycle is always greater than 50% — i.e., the Output is high for longer than it is low. Also the first pulse after power-on is always longer than those which follow, because the voltage across C1 initially starts at 0V instead of Vcc/3.

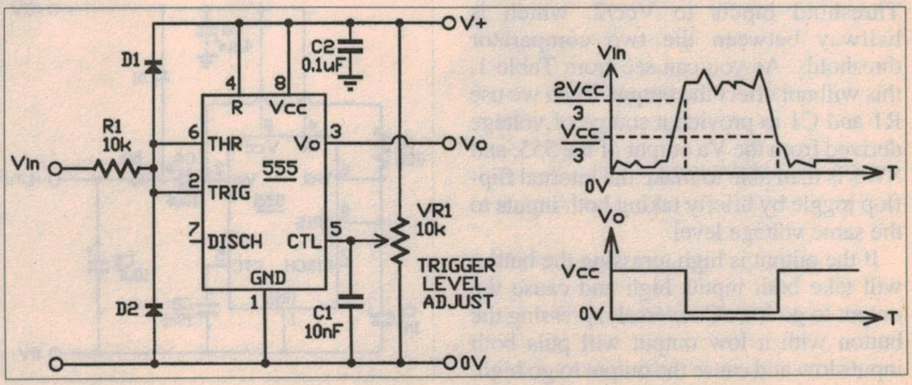
The frequency limitations of this circuit are determined by the same criteria as for the monostable circuit. At high frequencies, propagation delay times within the 555 also have to be considered.

Fig.6 (top): By connecting the 555 as shown, it can produce a squarewave with an accurate 50:50 duty cycle.
Fig.7 (upper centre): This circuit allows the duty cycle to be varied over a wide range, without changing the frequency.
Fig.8 (lower centre): A constant-current source turns the astable into a sawtooth generator.
Fig.9 (bottom): The 555 can also be used as a Schmitt triger, to clean up noisy waveforms.









Square wave astable

This is the simplest of the 555 astable circuits (Fig.6) to give a symmetrical square wave output. For the bipolar type 555 however, a pullup resistor (R2) should be used if an accurate 50% duty cycle is required. Without this resistor, especially with a loaded output, the output does not fully reach Vcc and the charge and discharge paths are not symmetrical. CMOS types, unless heavily loaded, do not need this.

To vary the duty cycle without varying the frequency, the circuit of Fig.7 can be used. This circuit is good for controlling power to DC lamps and DC motors.

Sawtooth generator

A constant-current source can be used with the 555 in astable multivibrator mode, just as with the monostable mode of Fig.4, to give a linear sawtooth waveform generator. The circuit is shown in Fig.8. Here frequency range can be adjusted by using different values for timing capacitor C1, while VR1 becomes the fine frequency adjustment.

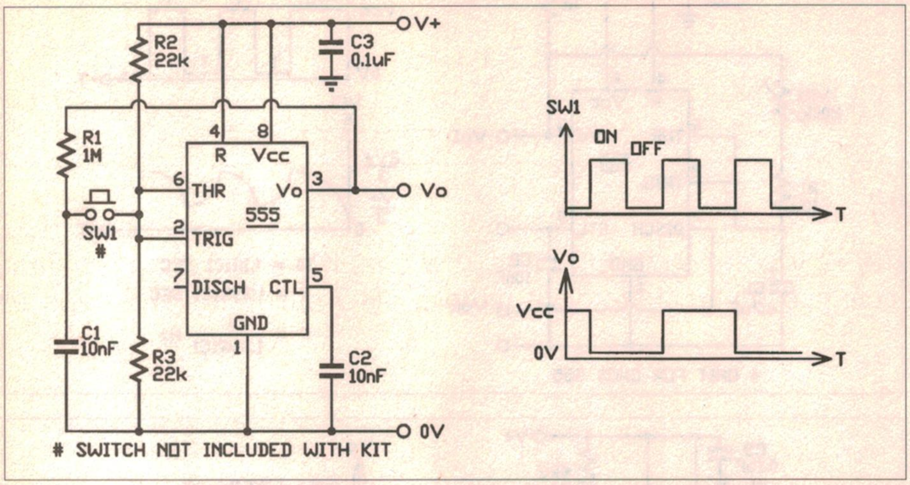
Resistor R5 sets the 'flyback' time, in conjunction with C1. The sawtooth waveform appears across C1, while a rectagular pulse output is also available at the 555's Va output.

Schmitt trigger

Because the Threshold and Trigger inputs of the 555 are level triggered and not edge triggered it can be used as to convert sloping or noisy waveforms into square pulses (Fig.9). At the Va output appears a squared-up waveform, with its transitions corresponding to the points where the input voltage crosses the 2Vcc/3 and Vcc/3 thresholds (modified by the setting of VR1). Note that the output waveform is inverted with the respect to the input.

Diodes D1 and D2 prevent high voltage or negative waveforms from damaging the inputs, and R1 ensures that the currents through D1 and D2 are not excessive. The Control input voltage can be varied by VR1 to adjust the trigger levels if necessary.

Multipurpose 555 Module



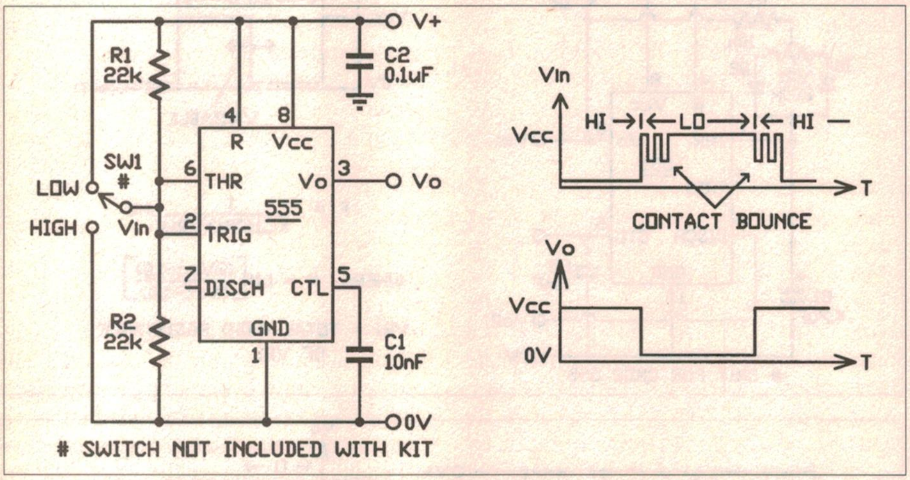
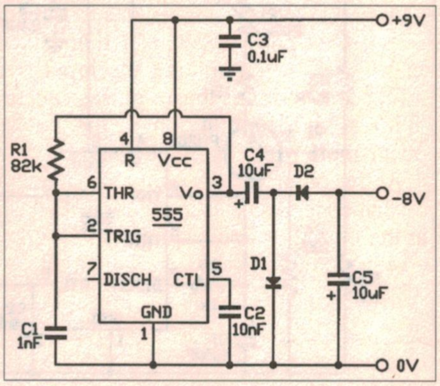
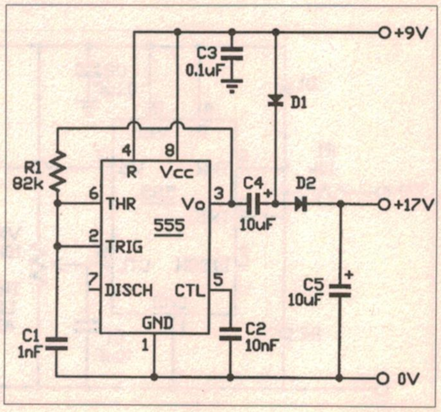


Fig.10 (top): The 555 used as a manual toggle, with a pushbutton.
Fig.11 (above): Using it to clean up or 'debounce' a switch.
Fig.12 (right): A negative voltage 'charge pump' generator.
Fig.13 (lower right): A positive voltage 'charge pump' booster.





Manual toggle

A single pole, single throw (SPST) pushbutton switch can be used as a push-on/push-off switch by configuring the 555 as a bistable/flip-flop. We do this (Fig.10) by using R2 and R3 to bias the Trigger and Threshold inputs to Vcc/2, which is halfway between the two comparator thresholds. As you can see from Table 1, this will not effect the output. Then we use R1 and C1 to provide a source of voltage derived from the Va output of the 555, and SW1 is then able to make the internal flip-flop toggle by briefly taking both inputs to the same voltage level.

If the output is high, pressing the button will take both inputs high and cause the output to go low. Conversely, pressing the button with a low output will puls both inputs low and cause the output to go high.

Switch debouncer

Many digital circuits are sensitive to contact 'bounce' in mechanical switches, and will respond to the additional transitions as extra input pulses — unless the switch input is 'debounced'. This can be done for a single pole, double throw (SPDT) switch or pushbutton using a 555 in the circuit of Fig.11.

Again we tie the two 555 comparator inputs together, and bias them at Vcc/2 (which only applies when the switch is 'between contacts'). Then the switch is used to pull the inputs either up to V+ or down to 0V, and each transition results in a single output transition regardless of any contact bounce.

Voltage converters

This circuit (Fig.12) is very useful for converting a single rail power supply such as a battery into a dual polarity supply, to run op-amps, etc.

The 555 is simply used as an astable feeding into a voltage clamp formed by C4 and D1, followed by a filter using C5 and D2. When pin 3 goes high, C4 charges close to Vcc via D1. When pin 3 goes low, the voltage on C4 is transferred through D2 to C5 and hence makes the output negative. The output voltage will be approximately equal to Vcc minus two diode drops. A similar but slightly different circuit (Fig.13) can be used to produce a second supply rail of the same polarity, but almost double the existing supply rail voltage. Here the polarities for capacitors C4 and C5, and diodes D1 and D2, are reversed, and D1 is taken to the input supply rail. This produces an output voltage of roughly double the input rail, again minus two diode voltage drops.

Summary

These circuits are just a sampling of the many different uses for a 555 timer chip, and of the wide range of circuits given in the manual for the Dick Smith Electronics K-2813 Discovery Kit. The 555 may be a simple and fairly elderly device by modern standards, but it's still very widely used because of its enormous flexibility.

Needless to say the DSE kit can be used to build up virtually any of these circuits, plus many others based on the 555. In the kit you get the special PCB (61 x 45mm), a TLC555 chip, three different transistors (for things like output driving, or a constant current source), seven diodes, two red LEDs, a 3.9V zener diode, 26 resistors, 13 capacitors, four trimpots, six PCB terminal pins and a 9V battery snap lead — just about everything you'll need to try out any 555 circuit configurations !

It's an excellent way to get familiar with this versatile device. ❖

Experimenting with Electronics

by DARREN YATES, B.Sc.

The 555 timer IC, part 2

This month, we look at some more ways to use this common, low-cost IC — including a battery charger, an ignition killer, a capacitance meter adaptor, a simple CRO calibrator and even an unusual audio amplifier.

For what really was one of the first 'specialised' ICs, the 555 is really the number one IC in electronics. There would hardly be an electronics experimenter anywhere in the world who hasn't built at least one circuit using this flexible little 8-pin IC.

It also shows up what a versatile design the IC is, as well. Most special ICs tend to fall by the wayside quickly, once something else better comes out of the fabrication lab, but the 555 continues to find its way into beginner's kits and even high-end equipment.

Some people have come up with some pretty unusual applications for the 555 timer, but the most unusual of all would have to be a circuit that was published in our very own *Electronics Australia* way back in February 1980.

I first saw it when I was still in short pants, and it certainly caught my young mind as I rummaged around the local library. Using the 555 timer as an audio amplifier? Well, it's certainly unusual — if not very practical.

Audio amplifier

Just for completeness, the circuit for the amplifier is shown in Fig.1. You can get more power out of the more common four-transistor amplifier that we've looked at in a previous issue of Experimenting with Electronics, but it highlights an important technique that is used in some audio areas.

Looking at Fig.1, the only gain from the circuit comes from transistor Q1. While it doesn't look like it has a collector load to achieve any gain, it uses the internal 5kΩ resistor string inside the IC. That, in combination with the emitter resistor, produces a gain of about 3.5 — nothing to crow about but enough to show that the concept works.

So what does the 555 do? It actually works on a similar principle that we used in the drill speed controller from last time. Using Pulse-Position Modulation (PPM), we can actually change the frequency of the output by modulating the control input at pin 5.

In practice, the 555 produces a stream of positive going pulses which are fixed in length. By modulating the input, we affect how often these pulses occur. With a high input voltage, the pulses occur more often and vice versa.

At this point, it's not really the frequency that concerns us. The digital waveform at the output of pin 3 is really a digitally encoded copy of the input modulation signal. We can regain that signal by simply average out the digital pulses. And that task is done by the speaker.

The trick here is that the 555 timer is set to provide a very narrow pulse so that the overall frequency is quite high. Ideally, it should be 50kHz and up, so that the speaker cannot respond to it. With a high enough frequency, the speaker can't respond quickly enough and simply averages the signal, and we hear the original audio signal at the output.

A more common approach to audio amplifier design is to use a close cousin to pulse-position modulation, called *pulse-width modulation* (PWM), whereby the frequency remains constant and only the duty cycle of the waveform changes. The benefit of this method is that since the modulated frequency doesn't change, you can easily set up filtering to remove it from the audio output.

Battery charger

This second circuit uses the 555 as a window comparator, to control the current flow to a bank of NiCad batteries.

Here the control input at pin 5 is tied to 5.1V via the zener diode, and is used as the reference point. If the battery voltage falls below the 2.55V, then the 555 is triggered and the output goes high. Note that by tying pin 5 to the zener diode you take out the top resistor in the internal string so instead of the timer working off the common 1/3rd and 2/3rd voltage points, it simply is referenced to the zener diode voltage of 5.1V.

Trimpot VR1 allows you to adjust the voltage, so that you can have any number of cells in the battery from a minimum of three up to six.

The output at pin 3 simply feeds a current to the battery via the 100Ω resistor and diode D1. Also at this point, the discharge transistor at pin 7 turns off,

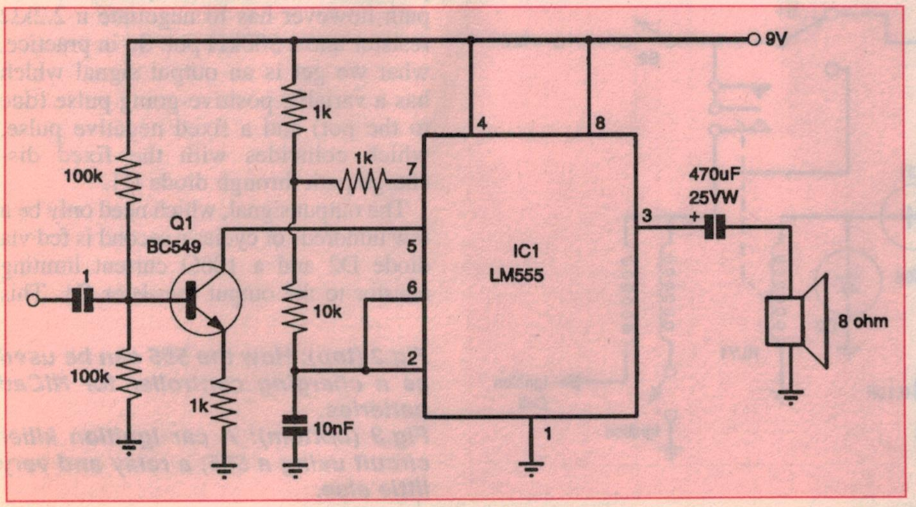


Fig.1: A somewhat unusual application for a 555, as an audio amplifier. It uses the 555 as a pulse-position modulator.

allowing LED1 to light up, indicating that the battery is being charged.

Once the battery voltage has risen above the threshold at pin 6, the timer is reset. The output at pin 3 falls low, and the discharge transistor at pin 7 turns on, shorting out the LED; which now turns off. Again the threshold is adjusted via trimpot VR2 which can be adjusted for any number of cells upwards of three to six.

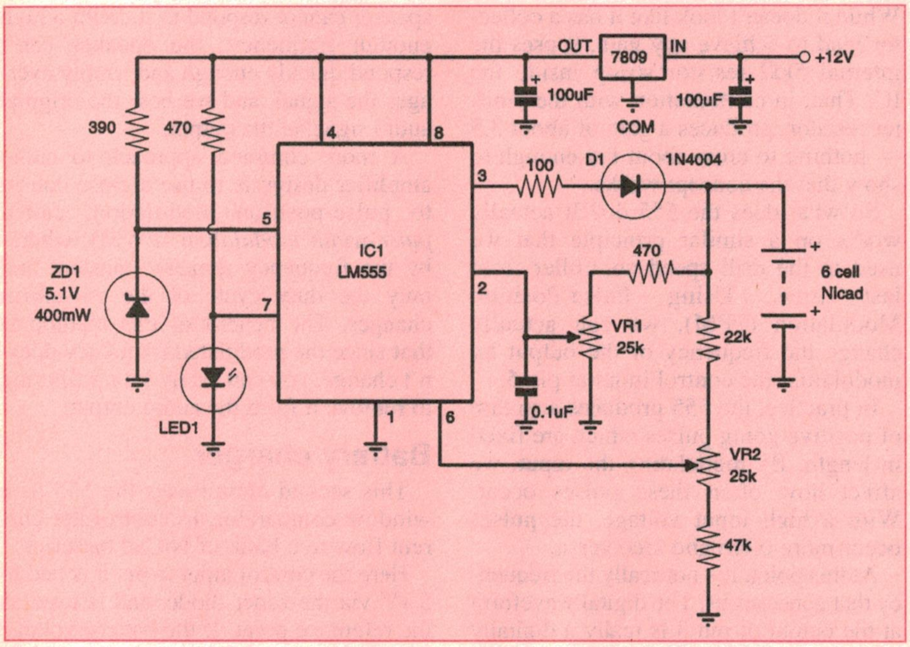
Power is supplied to the circuit via a 7809 regulator. You could quite easily use this circuit from a car cigarette lighter socket, but as you can imagine, there's plenty of room for experimenting.

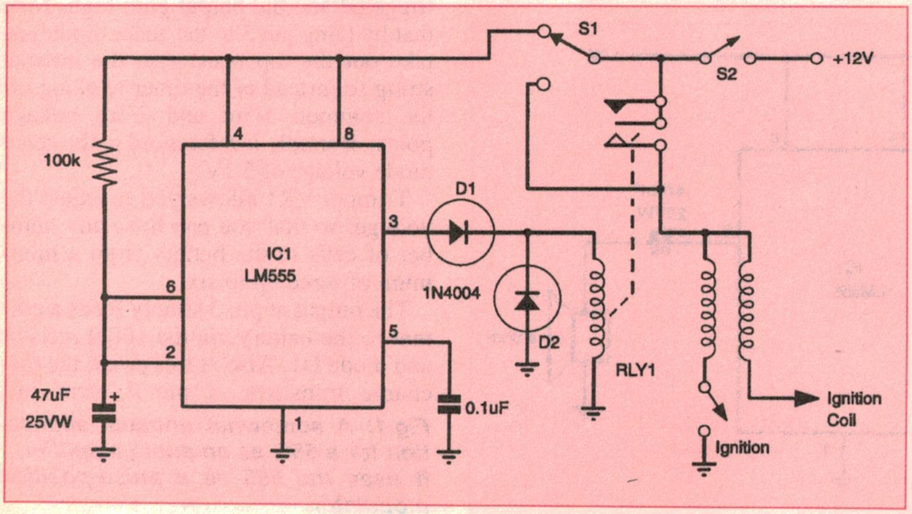
Car ignition killer

Some of the best ideas often spring from the simplest circuits. For some reason, people seem to think that the best way to stop a car thief is to make lots of noise. The only comments these types of car alarms attract these days are not printable!

But I don't know of too many car thieves who would bother stealing a car that doesn't work, and that's what this circuit does.

Looking at the circuit in Fig.3, the 555 timer is connected up as a simple monostable which has a time constant of about five seconds. When the alarm is 'armed' and the ignition is switched on, the 555 timer activates, sending the output at pin 3 high, and this pulls the relay into action. The relay contacts close and the starter motor kicks over.





But after five seconds or so, the 555 times out and the output falls low. The relay now drops out, the ignition is cut and the engine dies. Provided the circuit can be hidden out of sight, your average thief won't be able to afford the time to figure out your wiring and what's going on.

Diodes D1 and D2 protect the pin 3 output from reverse voltages caused by the relay coil when the output falls low.

You can keep the circuit as simple as possible or even build around it and use another 555 to provide a flashing warning light. Probably in this case though, the less the thief knows about what's happening the better. Better to have him (or her — hey, let's not be sexist!) think your car's a bit of a lemon, so they move on. That way you'll still have it...

Torch dimmer

If you've seen any of the latest torches that are being sold, you'll probably have seen that they produce a very bright output. Which is great if you need to see miles away, but if you just need to throw a little light on the subject, it could be a little bit of overkill.

This next circuit in Fig.4 again uses the pulse-position modulation scheme to create a torch dimmer.

Previously, a circuit of this type would contain little more than a big fat rheostat which sat in series with the batteries — very simple, but a waste of power. This solution is much more elegant and easier to control.

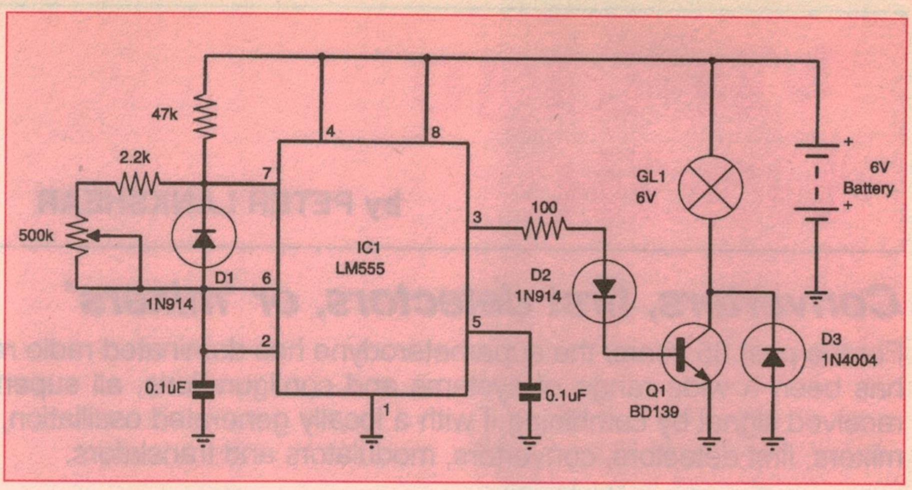
Looking at the circuit, the 555 is connected up as an astable multivibrator which has two separate charge and discharge paths for the timing capacitor.

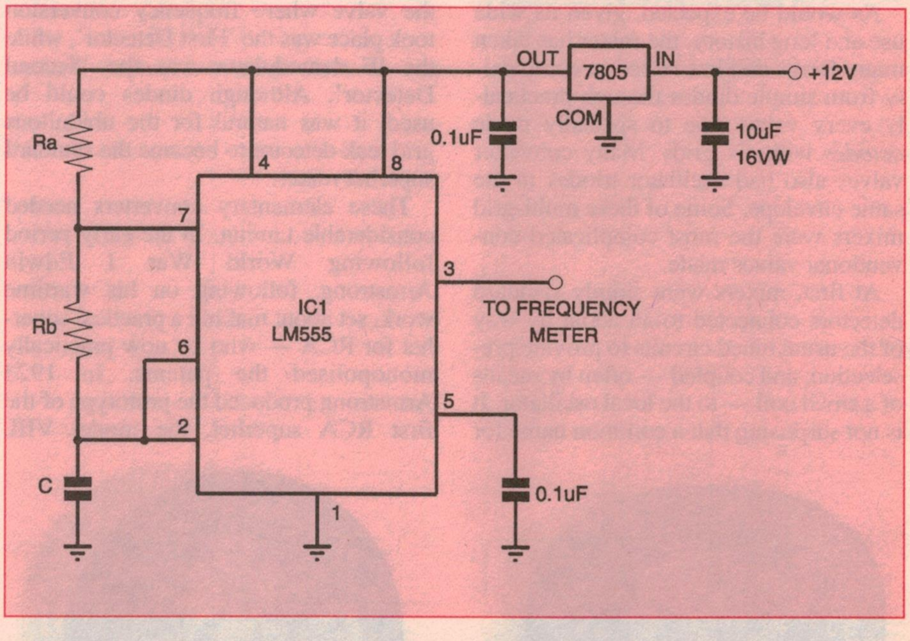
The discharge path is simple from the capacitor, through the diode, and down pin 7, back to the battery. The charge path however has to negotiate a 2.2kΩ resistor and a 500kΩ pot. So in practice, what we get is an output signal which has a variable positive-going pulse (due to the pot) and a fixed negative pulse, which coincides with the fixed discharge path through diode D1.

The output signal, which need only be a few hundreds of cycles a second is fed via diode D2 and a 100Ω current limiting resistor to the output transistor Q1. This

Fig.2 (top): How the 555 can be used as a charging controller for NiCad batteries.
Fig.3 (bottom): A car ignition killer circuit using a 555, a relay and very little else.

Fig.4 (top): An efficient torch dimmer circuit, again using the 555 as a pulse-position modulator. The globe responds to the average current.
Fig.5 (bottom): A simple 'capacitance to frequency' converter, which can be used to measure capacitors.





simply switches the globe on and off.

At these frequencies, the globe cannot respond quickly enough and simply glows at a level representing the average of the on and off times. For example, the output pulse was a 50% duty cycle ie, it is on for half the cycle and off the other half, the 6V globe would see 3V across it, and would be barely lit. If the duty cycle was 75% — i.e., the output was high for 3/4 of the time, the globe would see 4.5V across it and be lit more.

Diode D3 protects the transistor from the reverse effects caused when the globe is switched off. The globe is essentially a small coil, and generates back-EMF each time the transistor turns off. The back-EMF translates into a negative voltage, which if not controlled could blow the transistor.

It's a fairly common circuit and would really only be practical in one of those larger 'dolphin' style torches. Anything smaller would be quite a squeeze, but don't let that stop you...

Digital cap meter

Well, the title might be a bit pretentious, but this next circuit is quite handy if you need to measure the value of a capacitor and all you happen to have is a frequency meter. If we were pedantic, we'd call it a 'capacitance to frequency converter', but as you've probably seen from Fig.5, it's just a common 555 timer connected as an astable circuit.

What's actually more important about this circuit is the maths behind the chip, rather than the circuit itself.

If you're going to convert capacitance into frequency, then you need to make sure that all other parameters remain the same — so that the only thing affecting the change in frequency is the change in capacitance, and the 555 timer is ideal for this.

Looking at the circuit, the only critical thing you would need to keep an eye on is the length of the connecting leads from the inputs at pins 2, 6 and ground and the capacitor, especially at low values. At high values, you swamp the capacitance that's added by the leads but at low values, the few picofarads added could well throw your results way out of whack.

In fact, you couldn't really recommend this type of circuit below 100pF and expect to get any real accuracy. But since most capacitors themselves are only accurate to about 10% at best, it should be good enough for identification purposes if nothing else.

The maths for this type of circuit suggest that the frequency of oscillation is set to:

$F = 1.44/((R1 + (2xR2)) \times C1)$

Now if you keep both R1 and R2 constant, the only thing that will cause the frequency to change is a change in the capacitance. The good news is that the relationship is directly proportional — i.e., a 50% decrease in capacitance causes a 50% increase in frequency.

But as the capacitance value drops, the frequency increases, so you'll need to be able to measure the period or time of each cycle. Failing that, you'll have to do a little maths and convert the frequency into a period and work out the value that way against a known value. With practice, you won't need to work out for long as you'll remember key frequency points as being certain values.

A little time consuming, but if you can't afford an all-singing capacitance meter then it's not a bad alternative. By the way, this circuit is actually used in some kit capacitance meters!

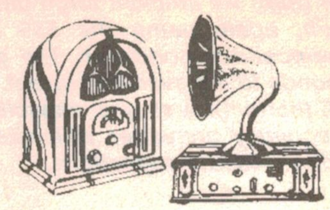
CRO calibrator

If you're serious about electronics and designing your own circuits, sooner or later you'll end up needing a CRO. They're probably about the most versatile bit of test gear you could have on your bench. You can measure both voltage and time, and see their interaction on screen. Many problems with complex circuits can only be seen on a CRO screen, so it's worth the investment.

The only problem is that the new ones are quite expensive, so if you end up with an older unit, you could well need to use a CRO calibrator.

(Continued on page 87)

Vintage Radio



by PETER LANKSHEAR

Converters, first detectors, or 'mixers'

For the past 65 years, the superheterodyne has dominated radio receiver technology. Although there has been a wide range of systems and configurations, all superhets change the frequency of the received signal by combining it with a locally generated oscillation, using devices known variously as mixers, first detectors, converters, modulators and translators.

As would be expected, given its wide use and long history, the mixer has taken many forms and has varied in complexity from simple diodes through practically every valve type to specially made *octodes* with six grids. Many converter valves also had oscillator triodes in the same envelope. Some of these multi-grid mixers were the most complicated conventional valves made.

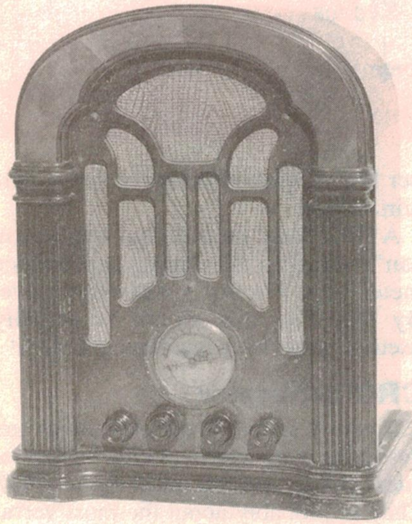
At first, mixers were simply standard detectors connected to an aerial by way of the usual tuned circuits to provide preselection, and coupled — often by means of a small coil — to the local oscillator. It is not surprising that a common name for the valve where frequency conversion took place was the 'First Detector', while the IF demodulator was the 'Second Detector'. Although diodes could be used, it was natural for the ubiquitous grid leak detector to became the standard superhet mixer.

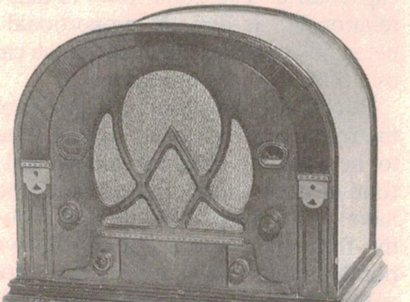
These elementary converters needed considerable taming. In the early period following World War I Edwin Armstrong, following on his wartime work, set about making a practical superhet for RCA — who by now practically monopolised the patents. In 1923 Armstrong produced the prototype of the first RCA superhet, the model VIII, which as can be seen from Fig.1 was remarkably complex. In fact without a few clues, the circuit operation is difficult to analyse.

Briefly, the first valve is reflexed, functioning as both an RF and first IF amplifier. The next valve also combines two operations, as a self-oscillating or 'Autodyne' mixer. The reason for this complication was economy. TRF receivers at the time had at most five valves, but a straight superhet needed eight — far too expensive to be competitive. Armstrong therefore countered this by the doubling up on valve functions, and got the count down to six.

As these early superhets used a very low frequency IF, typically about 50kHz, a self-oscillating mixer had considerable problems from strong signals pulling the oscillator off tune. Armstrong's remedy was to use the second harmonic of the oscillator. This cured the pulling problem, but as higher harmonics will also beat with a carrier, and with no ganging of the tuning capacitors, or image rejection, it was possible with one of these sets to tune a transmission above about 1250kHz at six settings of the oscillator dial!

Another problem of harmonic mixing was excessive noise generated by the mixer stage, creating a background hiss. Consequently, to minimise these problems in the next series of RCA superhets, separate inductively-coupled oscillator and mixer valves were used.





In the course of one year (1933/34), American manufacturer Atwater Kent produced receivers using three different conversion systems. Above is the five valve model 165, with a pentode autodyne converter; at upper right is the model 206, with a 2A7 pentagrid converter; and at right the 217, which had a triode oscillator and separate pentode mixer.

Tetrode, pentode mixers

In 1930, RCA was obliged to issue superhet licences freely. Tetrodes had become available and were shortly to be overtaken by pentodes. When biased to near cutoff, these valves proved to be good frequency converters.

Oscillator injection could be into the control grid, along with the received signal, and a common method was to wind

Converter valves came in a variety of shapes and sizes. These are both triode-hexodes, but the 1937 Mullard TH4A dwarfs the Osram X78 made about 15 years later. For all their differences in size, their performances are similar.

the oscillator and grid tuning circuits on the same former. This could lead to oscillator radiation from the aerial, and optimising oscillator injection over a wide range of frequencies could be difficult.

Although grid injection via a capacitor was not much used at low frequencies, for VHF services, including TV and FM reception, it proved to be very successful. For this service, several high performance combined triode and pentode valves, including the 6U8, ECF86, and 6BL8/ECF80 were developed.

Oscillators were normally very basic Hartley types, with a tuned grid coil and feedback provided by a small winding connected to the anode. Cathode injection proved to be the most successful for broadcast receivers using tetrode and pentode mixers. Fig.3 is of a typical application of this type, used by Atwater Kent in their model 217.

We do not always appreciate how expensive valves were during the early 1930s. It is difficult to translate prices into present day values, but at a time when a week's wages could be less than five pounds ($10), the list price of a typical valve was 17/6 ($1.75). Little wonder, then, that there was a reluctance to use two valves for a mixer if one would do. The autodyne was therefore resurrected using tetrodes and later, the new RF pentodes, and proved to be quite successful for broadcast band work. A typical application was the Atwater Kent model 165 as shown in Fig.4.

The Dynatron

Early electronics engineers were fond of what has been termed techno-Greek: titles made up from classic words. Two favourites were 'Dyne', meaning force and 'Tron', an instrument. Put the two together and we have the 'Dynatron', but in reality, one device so named was not as potent as its title implied.

The Dynatron was an oscillator in vogue for a short while and associated with a single valve type, the 224 screen grid tetrode. Tetrodes have the habit of being very unstable when operated with the screen voltage higher than the anode, for they can exhibit negative resistance characteristics, whereby the anode current actually increases as the voltage is reduced!

This is normally a nuisance, and one reason why basic tetrodes were rarely used as power amplifiers. However, if a valve is operating under negative resistance conditions with a tuned circuit connected to the anode, the system will oscillate. There is no need for external feedback and all that is required is a single untapped winding, an attractive situation for budget priced receivers. However, dynatron autodyne converters were temperamental and were soon abandoned.

There was at this time an increasing interest in shortwaves, but the small difference between signal and oscillation frequencies meant that pulling again made autodyne mixers unsatisfactory above a few megahertz. A separate oscillator valve as in Fig.4 was a partial solution, but expensive. What was needed was a purpose-built valve combining an oscillator and a mixer, but with as little interaction between the two as possible. A pair of conventional valves in the one envelope would still have the shortcomings of the triode-pentode mixer. What was needed was a new type of valve, with two independent control grids in a common electron stream.

The first Pentagrid

The pentagrid converter came from RCA in early 1933. Produced with both 2.5 volt and 6.3 volt heaters, the 2A7/6A7 had, as its name suggests, five grids surrounding the cathode. The inner two operated as a triode oscillator, modulating the electron stream from the cathode. Then followed two screen grids, with the signal control grid sandwiched between them. Around the first screen grid was a cloud of electrons or space charge, modulated by the oscillator frequency, and acting as a virtual cathode for the signal grid.

The second grid was in reality an anode for the oscillator, and, so as not to impede the main anode current flow,

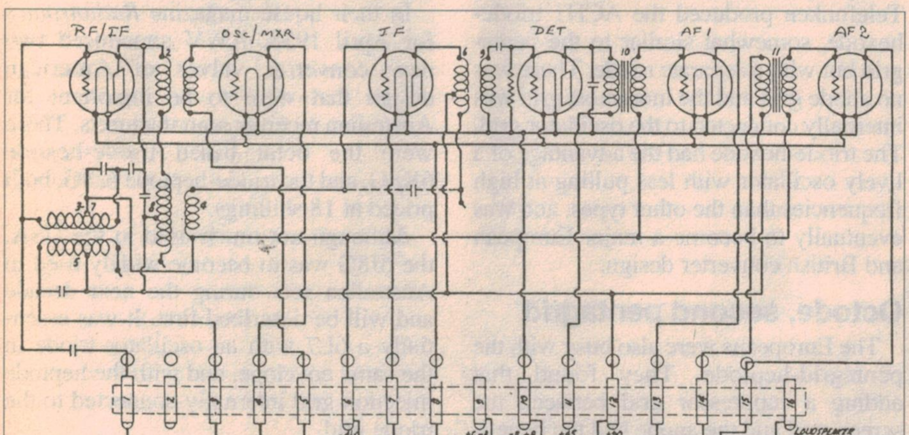
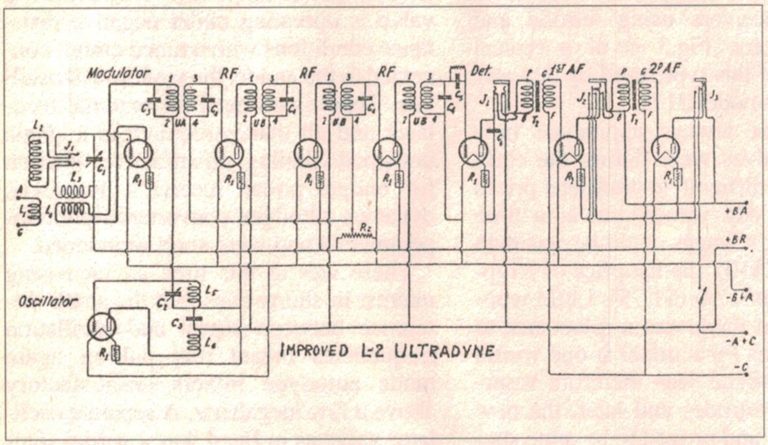


Fig.1: The first commercial superheterodyne was the Armstrong developed Radiola model VIII, using an autodyne mixer and released in 1924. Reflexing the input stage created a very complex circuit, made all the more daunting by many of the components being encased in a sealed 'catacomb'.

Fig.2 (below): Although during the 1920s, RCA had the manufacturing of superheterodynes tied up, they did not control the sale of kitsets and some rather interesting superhets were available to home constructors. Most followed more or less the Armstrong pattern, but designs like this one turned out by R.E. Lacault had novel, and by all accounts, effective mixer stages. Tracing out the mixer stage (modulator) reveals that there was no connection to the HT supply; instead the valve was energised by the oscillator.



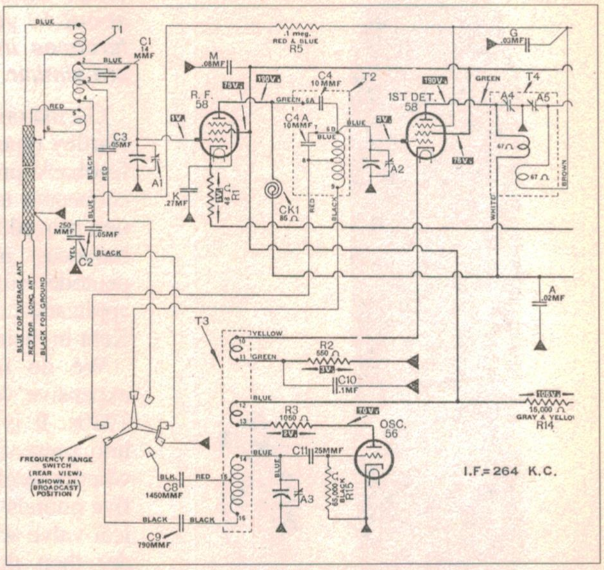


Fig.3: The converter section of the 1933 Atwater Kent 217, using a typical triode oscillator and pentode mixer combination. The wave change switch permited tuning to 3MHz, to cover the police and lower amateur bands.

could not be a solid element. It was found that even a minimal number of conventional grid turns was too restrictive, and in the final development the anode-grid consisted of just the two grid support rods, without any grid wires at all! The anode area was, of course, very small, and proved ultimately to be a limitation.

For a first effort however, the pentagrid proved to be remarkably successful, and was an industry standard until the 1940s. Within a few months of its American debut, it was introduced to Britain by British Ferranti as the VHT4. When RCA's range of metal valves was launched, the original pentagrid valve was repackaged unmodified as the 6A8, and in 1939 America's Sylvania incorporated the same valve in their Loktal valve range as the 7B8.

Different terminology

American terminology used for the early converters differed from European. At first, US identification was by the number of grids, whereas the British and European system was based on the total number of electrodes. Therefore the American pentagrid was the British and European *heptode*, but individual valves differed considerably.

The original pentagrid design had some imperfections. A fair degree of oscillator activity was required, but was made difficult at high frequencies by the restricted area of the anode-grid. Difficulties were also experienced in tuning above about 15MHz by strong signals pulling the oscillator frequency, and AGC applied to the control grid could also affect stability.

A combined triode-pentode, the 6F7 was intended to be a useful and versatile valve. One proposed function was as a pentode mixer with a triode oscillator, but this method of frequency conversion had already been tried with no advantages over the pentagrid and the 6F7 was therefore rarely used as a mixer.

Meanwhile, the Europeans had been doing their own research, and in 1934, Telefunken produced the ACH1 triode-hexode, somewhat similar to the pentagrid but with a separate triode. There was no anode grid and the innermost grid was internally connected to the oscillator grid. The triode-hexode had the advantage of a lively oscillator with less pulling at high frequencies than the other types, and was eventually to become a major European and British converter design.

Octode, second pentagrid

The Europeans were also busy with the pentagrid-heptode. They found that adding a suppressor grid between the screen grid and the anode had the beneficial effect of decreasing internally generated noise and of reducing anode current. This new valve they called an *octode*. One of the first, the Philips AK1, and later versions, the AK2 and EK2 were frequently used in Australian receivers.

There was a second mixer in the original 1935 metal valve series. This was the 6L7, another pentagrid but with a quite different internal structure from the 6A8, and which required a separate oscillator. The inner element of the 6L7 was now the main control grid. Then there were two screen grids, surrounding the oscillator injection or second control grid; a suppressor grid; and finally the anode.

Intended for high performance receivers where the cost of an extra valve was of little consequence, the high frequency characteristics of the 6L7 were superior to the other mixers.

In their house magazine *Radiotronics* for April 1938, AWV announced two new converter valves of American design that were to be important for Australian receiver manufacturers. These were the octal based triode-hexode 6K8G, and the triode-heptode 6J8G, both priced at 18 shillings.

Although not much used in the USA, the 6J8G was to become widely used in Australian sets during the next decade and will be described first. It was essentially a 6L7 with an oscillator triode in the same envelope, and with the heptode injection grid internally connected to the triode grid.

The European terminology of heptode was used for the pentagrid section of the 6J8G, which by the way, was never made with a metal or GT envelope; but it was put by Sylvania into a Loktal envelope as the 7J7. This adoption of European terminology seems to have been to avoid

confusion with the *third* type of pentagrid, to be described shortly.

About the only real weakness of the 6J8G was its low conversion gain, of about half that of many converters; but in practice this was hardly discernable. This minor problem was overcome later in an improved triode-heptode, the 7S7.

USA's only triode-hexode

Europe may have had reasonable success with the triode-hexode, but America seems to have had but one solitary example: the 6K8 (and its 12 volt companion the 12K8). Not only was it the sole American triode-hexode, but it had a most unusual construction. In fact, it could almost be described as a pentagrid with an outboard triode!

A close inspection of a 6K8G or GT will show that whereas conventional

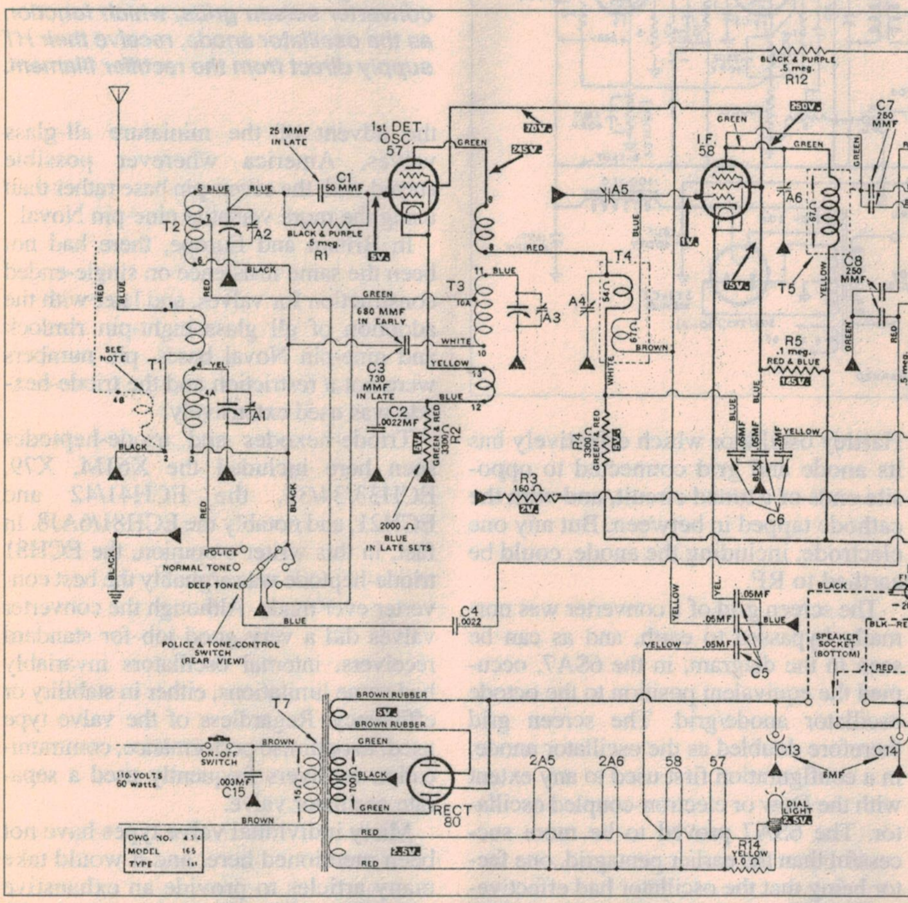


Fig.4: Atwater Kent's model 165 had a typical pentode autodyne converter, with the oscillator tuned winding closely coupled to the anode and cathode by way of similar windings on the same former. In several of their smaller sets, including the 165, AK combined the police band wavechange and tone switches.

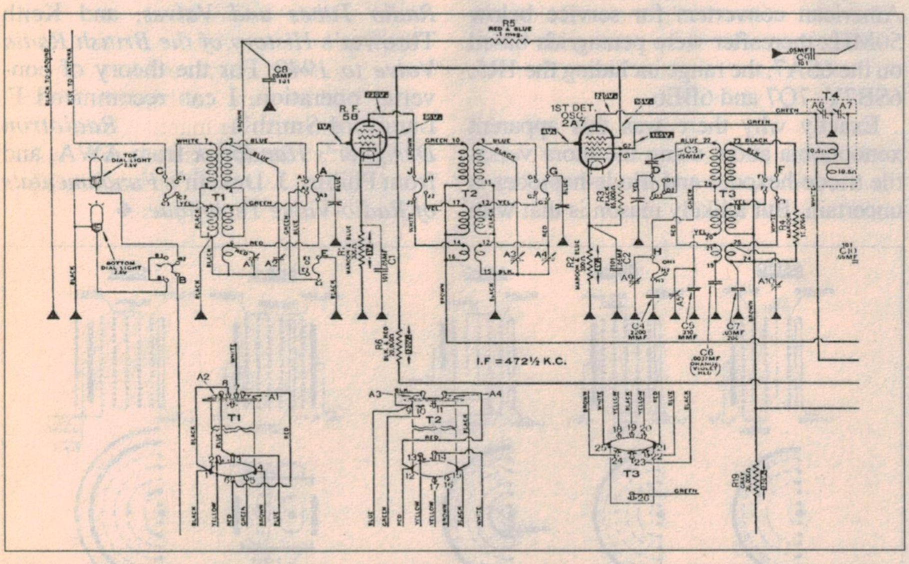


Fig.5: The first converter valve, the 2A7 pentagrid was used for the three band 1934 Atwater Kent 206. To improve stability, the oscillator HT was derived directly from the rectifier filament.

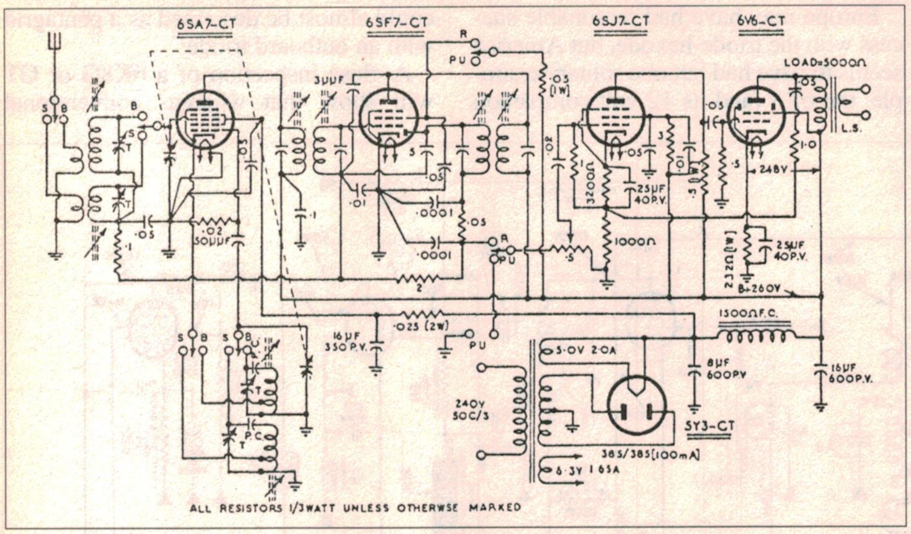


Fig.6: Just 50 years ago, Australia's AWV Co published this circuit using the American 6SA7GT 'third generation' pentagrid converter. The oscillator coils are single tapped windings and the converter screen grids, which function as the oscillator anode, receive their HT supply direct from the rectifier filament.

valves had the elements spaced concentrically around a central cathode, the 6K8 cathode was decidedly off-centre. In Fig.7 the two sections of the valve can be seen to be separated by the cathode.

One grid completely surrounded the cathode in the normal manner. This functioned as the oscillator control grid on the triode side, and as the injection grid on the hexode side. The next element on the hexode half was the screen grid, but instead of being centred around a cathode, it surrounded the hexode control grid. Finally, each section had its own anode.

America did not persevere with the triode-hexodes and triode-heptodes, although they were very successful across the Atlantic. The availability of only seven active socket pins on a single-ended metal valve may have been a factor. The original concept of the metal valve was for single-ended construction, but this was not properly realised until 1938 with the release of the series that included the 6SK7 and 6SQ7 — and yet another pentagrid, the 6SA7.

A third, US pentagrid

The pin shortage was circumvented in the 6SA7, by eliminating the oscillator anode. But how can a mixer oscillate without an anode in the oscillator section?

Fig.6 is an example of how it was done. Most converter systems, including even the Lecault circuit, used a Hartley oscillator which effectively has its anode and grid connected to opposite ends of a tuned circuit, and with the cathode tapped in between. But any one electrode, including the anode, could be earthed to RF.

The screen grid of a converter was normally bypassed to earth, and as can be seen in the diagram, in the 6SA7, occupied the equivalent position to the octode oscillator anode/grid. The screen grid therefore doubled as the oscillator anode, in a configuration first used to any extent with the Dow or electron-coupled oscillator. The 6SA7 proved to be more successful than the earlier pentagrid, one factor being that the oscillator had effectively a far greater anode area — although it is arguable whether it was as good as the European triode-heptodes. All new American converters for service below 50MHz thereafter were pentagrids based on the 6SA7, the range including the 1R5, 6SB7Y, 7Q7 and 6BE6.

Exactly why there was this apparent xenophobia about using the more versatile triode-hexodes and triode-heptodes is uncertain. But a likely reason is that with the advent of the miniature all-glass valves, America wherever possible stayed with the seven-pin base rather than using the more versatile nine-pin Noval.

In Britain and Europe, there had not been the same insistence on single-ended construction for valves, and later with the adoption of all glass eight-pin rimlock and nine-pin Noval bases, pin numbers were not a restriction and the triode-hexode was used extensively.

Triode-hexodes and triode-heptodes seen here included the X61M, X79, ECH33/34/35, the ECH41/42 and ECH21, and notably the ECH81/6AJ8. In fact, in this writer's opinion, the ECH81 triode-heptode was arguably the best converter ever made. Although the converter valves did a very good job for standard receivers, internal oscillators invariably had some limitations, either in stability or efficiency. Regardless of the valve type used, to optimise performance, communication receivers frequently used a separate oscillator valve.

Many individual valve types have not been mentioned here, and it would take many articles to provide an exhaustive treatment of the converter story. In-depth historical information will be found in John Stokes' book *70 Years of Radio Tubes and Valves*, and Keith Thrower's *History of the British Radio Valve to 1940*. For the theory of converter operation, I can recommend F. Langford-Smith's *Radiotron Designer's Handbook* from AWA, and from Philips, J. Deketh's *Fundamentals of Radio-Valve Technique*. ❖

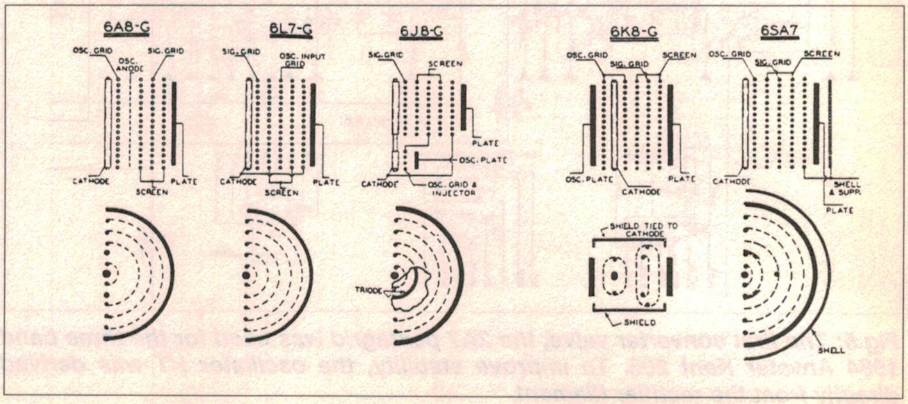


Fig.7: These drawings, showing clearly the different internal details of the American pattern converters, are from the 1940 edition of the 'Radiotron Designer's Handbook'.

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A low cost RF oscillator design that is suitable for checking and aligning HF radios and other equipment operating between 350kHz and 30MHz. Features digital frequency readout, the ability to provide either CW or modulated output and also audio and 1 MHz reference signals from auxiliary outputs at the rear. **EA May '96**

SMART DUAL 12V BATTERY CONTROLLER

K10740 $49.95 NEW

This auxillary battery manager takes full advantage of a dual battery setup's capabilities, by controlling when and how the "auxiliary" battery is connected to the electrical system. It's fully automatic, will cost you far less than an equivalent commercial unit, and is particularly suited to the new breed of deep-cycle auxillary batteries

EA JAN'96

PC DRIVEN EGO SENSOR ANALYSER

K10735 $39.45

With car engine management systems becoming more and more sophisticated (and complex), it is getting increasingly difficult to find out what's happening "under the hood". This low cost analyser, combined with any IBM PC and some special software can provide a large amount of information on your car's performance. **EA JAN'96**

LOW COST MICRO-BASED ESR & LOW OHMS METER

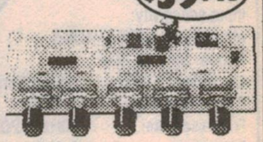
SHORT FORM K10730 $44.95 NEW

If you repair switch-mode supplies, TV receivers, computer monitors, vintage radios, or similar equipment, and/or if you need to measure very low values of resistance, this project can save you lots of time and aggravation. It measures an aspect of electrolytic capacitors performance which is very important, but normally very difficult to check: the equivalent series resistance, or "ESR" **EA JAN '96**

LOW COST FIVE BAND EQUALISER

Liven up your keyboard, guitar or music system with this 5-band equaliser. It only uses a few low cost parts and will enable you to "customise" the sound of your system just by twiddling a few knobs **SC DEC'95**

K10735 $39.45



ENGINE IMMOBILSER

K10720 $33.95 NEW

This circuit will immobilise your car if a thief tries to start it. Fit it to your car as cheap insurance. If a thief tries to steal your car, the engine will repeatly stall and he will move to easier pickings. **SC Dec'95**

GEIGER COUNTER

NEW K10715 $168.95

Are you concerned by the Nuclear tests in the Pacific and China? Worried about a possible increase in the amount of background radiation? Then check it out with this Geiger counter. It will detect alpha, beta and gamma radiation and has an audible output **SC Oct'95**

Geiger Tube available at $119.00

A MIXTURE DISPLAY FOR FUEL INJECTED CARS

K10710 $15.95

This simple project allows you to monitor the fuel mixtures being run by your car. You can also use it as a tuning tool, to help in vehicle modification, or simply to see the behaviour of the engine control module. It is based on an LM3914 chip and ten LEDs **SC Nov'95**

MODEL TRAIN CONTROL WITH SIMULATED INERTIA

This simple, low-cost train controller uses a very efficient phase control system to regulate the speed of your model train, giving better load-speed regulation. It also simulates inertia and momentum, making the train run much more realistically. Together with a couple of other features this makes the controller a worthwhile addition to almost any layout. **EA OCT'95**

NEW K10705 $34.45

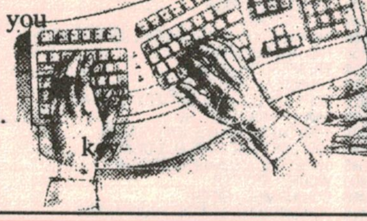
FAST CHARGER FOR NICAD BATTERIES

K10700 $118.95 NEW

This nicad charger lets you fast charge nicad battery packs from a 12V car battery. It can charge packs of 5 to 10 cells at once and automatically reverts to trickle mode at the end of the charging cycle. **SC OCT '95**

EAKIT896 - JUN 1996

LOOK! OEM Microsoft Natural Keyboard for only $95.00



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Cat No.	Processor Part	Performance Rating	Bus/Clock Speed	Marking on CPU	Price	With Motherboard
			CYRIX CPU			
U21002	6x86-P120+GP	P120+	50/100 MHz	6x86-100 P120+	**$299**	**$479**
U21004	6x86-P133+GP	P133+	55/110 MHz	6x86-110 P133+	**$349**	**$529**
U2100	66x86-P150+GP	P150+	60/120 MHz	P150+	**$379**	**$599**
U21008	6x86-P166+GP	P166+	66/133 MHz	P166+	**$599**	**$779**
			IBM CPU			
U21003	6x86-P120+GP	P120+	50/100 MHz	100/6x86	**$219**	**$399**
U21007	6x86-P150+GP	P150+	60/120 MHz	120/6x86	**$399**	**$579**

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J89070 **$169**

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Cat No.	Description	1-9	10+
T90764	*2SC4242*	**$3.95**	**$2.95**
	2SC2810	**$3.95**	**$2.95**
	220uF 200u Electro	**$2.50**	**$1.95**
Z10468	*Twin Diode*	**$2.95**	**$2.50**
	TL494	**$2.95**	**$2.50**
	LM339	**$0.80**	**$0.70**
T90318	*BU508D*	**$5.50**	**$4.50**
T90330	*BUZ90A*	**$9.95**	**$8.95**

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semi professional model with all the features needed whether its being used in a church, party or even a wedding. Features include:
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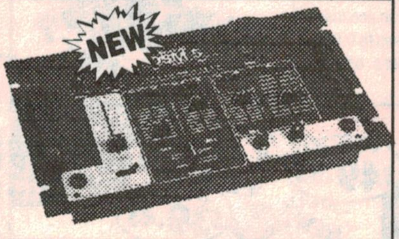

A12025 **$249**

Specifications

Input sensitivity:	
Microphone: 1.5mV / 10KΩ	
Phono: 3mV / 47KΩ	
CD: 150mV / 27KΩ	Line: 150mV / 27KΩ
Output sensitivity:	0.775V
Freq response:	20Hz to 20 KHz +/-2 B
Distortion:	0.01 %
S/N ratio:	60d B
Talkover attenuation:	-l2dB
Headphone input Imp:	32Ω @250mV
Input voltage:	220/240Va.c 50Hz
Tone controls:	
Treble:	10 K Hz +/-12dB
Bass:	100 K Hz +/-12dB
Dimensions:	380(W) x 220(H) x 40(D)mm

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15 watt wall mounted PA ampifier designed for a permanent installation and lockable. This amplifier is ideal for use in schools, small halls, fast food outlets or anywhere requiring only a basic PA system away you go.

Specifications:

Power Output:	15Watts RMS
Speaker Output:	8 tp 16Ω
Microphones:	250 to 600Ω UnbaLanced
Auxlliary:	10KΩ -20d BV
Freq Resp:	50 to l5KHz -/+20d8
THD:	<5% Q 1 KHZ rated output
Signal : Noise	Better than 65d8
Power Requirements:	AC240Vac 50Hz
Cabinet Material:	Sheet metal+phosphate

A12029 **$179** NEW

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X18005	High Speed I/O	$59.95
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X18165	16bit ETHERNET RJ45 + BNC	$49
X18169	16bit NE2000+	$119
X15810	Ethernet 5-port 10 base T hub	$169.95
X18159	Ethernet 10 base T Connector	$119
X18190	Printer 2-Port Slct Lpt 1-2 Card	$39
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X18041	High Speed Serial Card 2-Port 16550AFN	$69
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NEW!	Dual Speed 16650 UARTS modem chip	$99
X18019	Games Card	$19
C14260	SMART GAMES Cont	$39.95
X18514	FULL -DUPLEX ISA **ETHERNET**	$99
X18171	Ethernet **Intel PnP** BNC/RJ45 16-bit	$199
	*Ethernet **III Rev B Coax (BNC, AUI)**	$250

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X18047	VESA IDE ENHANCED MULTI I/O	$119
X18050	VESA IDE ENHANCED MULTI I/O- **PROMISE TECH**	$129
X18195	VESA VGA CARD	$149

	PCI	
X17900	PCI 1M VGA TRIDENT 9440	$149
X18206	PCI VGA DIAMOND STEALTH 1MEG DRAM	$169
X18207	PCI VGA DIAMOND STEALTH 2MEG DRAM	$199
X18208	PCI VGA DIAMOND STEALTH 2MEG VRAM	$529
X18209	PCI VGA DIAMOND STEALTH 4MEG VRAM	$999
X18483	PCI VGA CIRRUS LOGIC 5430 1MEG	$75
X18195	PCI VGA 64-BIT CIRRUS LOGIC 5436	$199
X18510	FULL -DUPLEX PCI ETHERNET	$99
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X18212	PCI MGA MILLENNIUM 2MB WRAM	$635
X18214	PCI MGA MILLENNIUM 4MB WRAM	$930
X18216	PCI MGA MILLENNIUM 8MB WRAM	$1530
X18510	PCI Ethernet BNC/RJ45	$149
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J89123 **$159**

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Pentium™ 166	$2150	$2490
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Pentium™ 166	$2590	$2945
Pentium™ 180	End of August	
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INFORMATION CENTRE

by PETER PHILLIPS

Zobel networks explained, and noisy meteors

I have an interesting mix for you this month. We start with letters explaining constant impedance (or Zobel) networks, then there's a letter about strange noises related to meteors. A reader describes a simple way to measure the impedance of coaxial cable, and our What?? question will particularly interest technicians who like to save effort.

As you know, this column is where we present letters from readers asking for, or giving, technical advice. I like to include as many letters as possible, which usually means some editing to reduce their length. This way we get variety, and as many readers as possible get their letters in the column.

But this month I'm including a couple of letters that are longer than usual, because their content is, I believe, going to be of general interest to most readers. The letters are about Zobel networks.

Never heard of such a thing? As you'll read, Zobel networks have a range of applications, but our main interest here is with the output stage of an audio amplifier. Of course, you might not be interested from a practical point of view, but you should find the general theory of these networks interesting.

These letters are in response to a question by a reader in the May issue, and as I had considerable difficulty finding information about these networks, I asked readers to help me out. And that's another reason I'm devoting space to this topic. While some technical books have information about Zobel networks, it's hard to find, and when you do find it, difficult to understand.

The first letter discusses the concepts and gives a general background to Zobel networks. The second, from Neville Thiele, gives more specific information. A third letter lists a few references in case you want more information. So without further ado, here's the first letter.

Inverse networks

In the May issue of Electronics Australia you asked for information about Zobel networks. This is in any standard text on network design, but is hidden under other names. Incidentally, are there two Zobels? The Zobel I know of was a pioneer in filter design in the Bell System and wrote a lot about network theory. His first paper in the Bell System Technical Journal was in 1922 and it seems surprising that he also wrote the article you quote in 1982.

Two topics which are fundamental to network theory are inverse networks and constant resistance networks, and both of these have relevance to what have become known as Zobel networks.

Two networks are said to be the inverse of each other if the product of their impedances is a constant. For example an inductance has an impedance of 6.28fL, and a capacitance has an impedance of 1/6.28fC. The product of these two impedances is L/C, which is constant at all frequencies, so they are inverse networks.

Similarly, the inverse of a capacitance and an inductance in series is an inductance and capacitance in parallel, with the same resonant frequency. Any network of elements has an inverse, and there are rules for designing the inverse of a network. Inverse networks were widely used in phase and frequency equalisers, as well as some filters. For example, the two halves of a crossover network are sometimes inverse networks.

A constant resistance network is a network of elements whose resulting impedance is a constant resistance at all frequencies. Such networks can be built from two inverse networks and two resistors.

Such a network is shown in Fig.1, and is made up of two branches. One is an inductor in series with a resistor and the other is a capacitor in series with a resistor of the same value. If $R^2 = L/C$ then the impedance of the whole network is a pure resistance R at all frequencies. The same result can be obtained with any two inverse networks of impedances Z1 and Z2 in place of the inductor and capacitor, provided $Z1 \times Z2 = R^2$.

The significance is that if you have a loudspeaker, a filter or whatever, which has a varying impedance and you want to connect it to something which is intolerant of this variation, it is possible to design a network which placed in parallel will make the combination look like a constant resistance. The procedure is to measure the impedance of the device over the frequency band, design an equivalent network and then create the inverse.

When I was younger this was part of the tool kit of transmission engineers. However we called them impedance correcting networks; the name 'Zobel networks' seems to be a recent innovation.

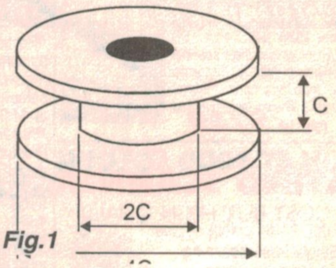

Fig.1

So far as loudspeakers are concerned, the value of such impedance correction is mainly in avoiding oscillations in the amplifier. A typical speaker's impedance is rather like a resistor in series with an inductor, so a capacitor and resistor in series will give some improvement. Strictly, these networks should be designed to match a particular speaker model, but it seems that a compromise network is satisfactory.

For more information about constant resistance networks, look in texts on circuit theory. Unfortunately, most of these are fiendishly difficult to follow and information about constant resistance networks will be scattered through the book. (Harry Freeman, Wollstonecraft, NSW)

Thanks for this overview of inverse networks, Harry. As you'll read further on, the *EDN* article I referred to had a few typos, including the date. It should have read 1928, not 1982. However, as far as we know, Otto Zobel died sometime in the

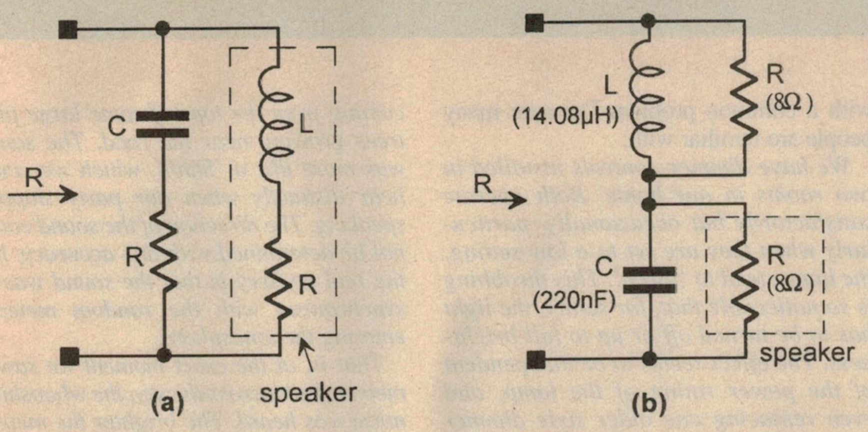

Fig.2

1980s, so it was not impossible that he was still writing in 1982.

Now here's the letter from Neville Thiele, who I'm sure needs no introduction.

Zobel networks

The circuits in Fig.2 show the two forms of the Zobel network as it is usually applied to audio amplifiers. Either network has the interesting property that so long as the inductance and capacitance are related by $L = CR^2$, the network presents a pure resistance (R) to its input terminals at ALL frequencies. You were worried that "the mathematics is somewhat complicated...", but don't worry; that is all the mathematics you need for this application.

The parallel form (a) is the one that is all too often used, assuming presumably that the loudspeaker and its connecting cable present an inductance L that is corrected by the series CR network. However this inductance obviously varies enormously with cables and loudspeakers.

I much prefer the series form (b), which requires an additional inductor but has the great advantage that the load it presents to the amplifier at high frequencies above the audio band is very much independent of loudspeaker and cable. At the same time it removes RF that is all too easily picked up by the speaker cable and fed back through the feedback network to the amplifier's input stage, where it is demodulated and thus produces audible clicks and pops when lights or refrigerators turn on and off.

I described this in my paper 'Load Stabilising Networks for Audio Amplifiers', in Proceedings of the IREE September 1975, pp 207-300, and reprinted in JAES January/February 1976, pp 20-23. Incidentally, since its publication I don't think anyone, including me, has taken further interest in Section 5 - Higher Order Networks. I can only say, following Gareth Evans' example of a prisoner at the bar, "Well, my lord, it just seemed a good idea at the time."

In Fig.2(b), a capacitor of 220nF was chosen simply because it is readily available and, with a CR time constant of 1.76us, it produces 3dB attenuation of the output at 90kHz, 1dB at 46kHz, and 0.25dB at 23kHz. These days, with most loudspeakers having lower impedances, it might be more appropriate to design it for a nominal 4Ω load with a 470nF capacitor. That would require an inductance of 7.52uH and its response would be down 3dB at 85kHz, 1dB at 42kHz and 0.25dB at 21kHz.

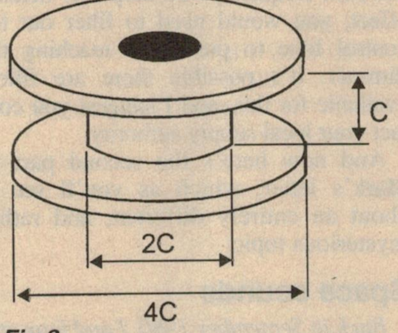

Fig.3

As described in the paper, the coil need only be small, although it does not give actual dimensions. It refers instead to another paper of mine: 'Air Cored Inductors for Audio', published in Proc. IREE, October 1975, pp 329-333, reprinted in JAES for June 1976, pp 374-378, with a postscript in December 1976, pp 830-832.

To show just how small the coils can be, I have calculated their dimensions for a series resistance chosen arbitrarily as 1% of the load resistance. The bobbin shape is in Fig.3, though the dimensions, both yielding an overall diameter of 4c, (around 18mm), are not critical. Tcoil is the ratio Lcoil/Rcoil, which has the dimensions of a time constant, and on which the linear dimensions c, 2c and 4c, and the mass of copper depend. This is shown in Table 1.

Since writing those papers, I have become more conscious of how the resistance of wires with diameters (dw) of 0.5mm and up increases significantly at the higher audio frequencies due to skin effect. I rather doubt it would cause much trouble in this application, though in my present haste, I haven't calculated the increase of series resistance at 15kHz/20kHz for these examples.

However, if you have any doubts you could wind the coils in bifilar fashion with two wires of the same length and each half the cross sectional area, and hence 0.71 the diameter of the specified wire gauges, (which gives 0.45mm and 0.55mm respectively). The two windings are connected in parallel to produce an elementary kind of Litz wire.

I must add a warning. Don't wind the coils on ferrite balun formers, as I did initially, to make them even smaller. The ferrite saturated and produced 5% THD at 20kHz with a 40 watt output.

Someone is bound to point out that such harmonics would fall well above the audio band but, as it seems I need to repeat far too often, such high frequency non-linearity produces intermodulation products that beat down into the audible range. My very best wishes. (Neville Thiele, Epping, NSW)

Neville included copies of the papers he refers to in his letter, and I've reproduced the relevant illustrations from them. So thanks Neville, for this precis of your excellent papers. It's good to be able to present such a practical description of this rather obscure topic.

Incidentally, younger readers may not know that Neville Thiele is regarded as a world authority on filter and loudspeaker

Table 1

R (ohms)	C (nF)	L (µH)	0.01R (ohms)	Tcoil (µs)	c (mm)	N turns	length (metres)	wire dia (mm)	mass (gm)
8.0	220	14.08	0.08	176	4.5	35	1.49	0.64	4.3
4.0	470	7.52	0.04	188	4.7	25	1.11	0.78	4.7

design and other aspects of electronics. He has been at the forefront of many innovations and designs for over 40 years.

The next letter on this topic gives the titles of some reference books and a small, but significant correction.

Useful texts

There appears to be typographical errors in the year and title of the reference you cited from the EDN magazine article. It should have read: Zobel, Otto J., 'Distortion Correction in Electrical Circuits with Constant Resistance Recurrent Networks', Bell Syst. Tech. Journal, Vol 7, July 1928, pp 438-534.

Two textbooks treating the subject are: Everitt, William L. 'Communication Engineering' 2nd ed, McGraw Hill 1937 (pp 287-293) and Terman, Frederick E. 'Radio Engineers Handbook', McGraw Hill 1943 (pp 244-249). Terman also references Kimball, H. 'Motion Picture Sound Engineering', Van Nostrand 1938, ch 16,17.

Modifying the phase angle of a load to stabilise a high power feedback amplifier is only one relatively recent application of the class of networks analysed by Zobel. Historically Zobel-inspired networks found their main applications as frequency and phase equalisers for long distance telecommunications circuits, broadcasting and sound reproduction. These designs have all but disappeared as the ever diminishing costs of semiconductors make buffered active filters cheaper than LC networks. (Ross Beaumont, Manager Radio Propagation, Telstra, NSW)

So that explains Harry's misgivings about the dates. Thanks Ross for these corrections, and for the names of some textbooks. Since reading your letter, I checked again for information in my own copy of *Electronic and Radio Engineering* by the above mentioned Terman (1955), but to no avail.

A recurrent theme is that Zobel networks are not used a lot these days. Certainly they can help stabilise a touchy output stage, but most of today's amplifiers are fairly stable anyway. So, while adding a Zobel network won't do any harm, it may not achieve anything. But at least we've now covered an area that, while limited in practical use these days, is part of the basics of design theory.

Now we move to our next topic.

Throbbing lights

The next letter asks for comments on two totally different topics. The first deals with a common problem I'm sure many people are familiar with:

We have dimmer controls installed in two rooms in our home. Both operate satisfactorily but occasionally, particularly when they are set to a low setting, the lamps tend to 'throb'. This throbbing is so noticeable that, for sanity, the light has to be turned off or up to full brightness. The effect seems to be independent of the power rating of the lamp, and even replacing one older style dimmer with a newer model did not fix the problem. Is there a simple remedy? (Matt Ryan, Coogee, NSW)

I'm not sure if there's a simple remedy Matt, but there's a simple explanation of your throbbing lights. The reason is the switching tones electrical supply authorities send over the power distribution system. These tones control off-peak power, typically water heaters.

I've noticed the same effect, usually around midnight or even later. The tones might last several minutes, and are sometimes repeated several times. I don't know how to stop them causing lights to throb, but knowing it will only last a few minutes might help.

The throbbing effect is the result of a beat set up between the injected tone and the 50Hz mains supply. The beat signal causes the triac control circuit in the dimmer to vary the brightness of the lamp at the beat frequency. To stop this beating effect, you would need to filter out the control tone to prevent it reaching the dimmer. It's possible there are filters available for this, and I suggest you contact your local supply authority.

And now here's the second part of Mark's letter, which as you'll see is about an entirely different, and rather mysterious topic:

Space sounds

Back in September 1980, I and four others had occasion to walk around a small farm in the Southern Tablelands, just south of Sydney. It was a particularly clear night and in the ionosphere above, maybe 100km away, was a spectacular display of meteors randomly streaking through the sky every few seconds. As they burnt up in the atmosphere their tails lingered for some five to ten seconds.

There is nothing really strange about this, and I'm told it occurs when the ionosphere is highly charged. However we marvelled at the sheer beauty of the sight.

Most of the time I was sure I could hear a 'whooshing' noise which seemed to be coming from the tops of some large pine trees growing near the road. The sound was more like a 'Shhh', which we could hear distinctly when our party stopped speaking. The direction of the sound could not be determined with any accuracy, but the real mystery is that the sound was in synchronism with the random meteors entering the ionosphere.

That is, at the exact moment we saw a meteor flash across the sky, the whooshing noise was heard. The brighter the meteor and the longer its tail, the more distinct the whooshing sound.

I've since chanced upon a copy of William Corliss' 'Unusual Natural Phenomena' and found to my delight that similar events have been witnessed. He writes: "Scientists regarded such observations as auditory illusions or the consequence of inexperience for many years, mainly because no acceptable physical mechanisms were available to explain the observations... Many investigators now accept the reality of the sounds and ascribe them to: (1) electromagnetic radiation perceived as sound, or (2) electrical discharge (brush discharge) arising from electrical effects created by this phenomena."

The author goes on to cite several case studies of this and similar phenomena, and similar sound connected with the aurora, fireballs and other electrical events. I'm not surprised to find that there is no valid explanation. Perhaps other readers have witnessed a similar event and have an explanation as to what is going on. (Matt Ryan, VK2KVE)

I've read of this sort of occurrence before, but I've no idea what causes it. I suspect the reason is probably quite mundane, but the intrigue is to find it. So if anyone can help, let me know.

50 & 75Ω BNCs

It seems this topic just won't go away. Over the last few issues I've included letters from readers describing how to tell the difference between a 50Ω and a 75Ω BNC connector. If you've kept up with the letters, you will have gathered by now that there is no simple and guaranteed way to do this. Unfortunately, according to the next contributor, every letter I've included in the May issue about this topic has it wrong.

The May issue of EA published wrong, misleading and irrelevant replies on the subject of 50 and 75 ohm BNC connectors. The first reply, from Harry Ackland, is mainly irrelevant and completely misses

the point. 75 ohm BNC connectors were created precisely because of the demanding impedance requirements of high quality television transmission systems (video baseband signals).

The reply from Chris Toms is just plain wrong. In fact 50 ohm plugs are available in sizes to fit 50 ohm and 75 ohm cables, so you should simply choose them correctly. However there are also true 75 ohm versions of BNC connectors, so there is an electrical difference if you need it to match the cable impedance.

The reply from Alan Fowler is nearer the truth on the electrical side, but is misleading on the physical side. Modern 75 ohm BNC plugs and jacks are truly physically compatible with 50 ohm versions, owing to some clever design tricks that result in the same thickness for the centre pins of both types. If you want proof, study a Huber & Suhner catalog. A modern 75 ohm plug would not be physically compatible with the original style 75 ohm jack that Mr Fowler describes. (Phil Lockley, West Pennant Hills, NSW)

As I see it Phil, the writers you refer to have described what they have found. Whether these experiences give the complete story is another matter. What is important is that I include the experiences of others. After all, if someone finds that this plug won't fit that socket, then why not tell other readers?

I agree there is far more to the topic, as you will have read in the June issue. In fact, it seems there is no simple answer, as there seems to be no such thing as a 'standard' 50 or 75 ohm BNC connector.

Our next letter is related to the above, but instead looks at how to measure the impedance of a length of coaxial cable.

Cable impedance

When the question was how to tell if a BNC connector is for 50 or 75 ohm cable, I suggested measuring its impedance. What I didn't do was describe how. Although the next letter doesn't either, it does give a simple method of measuring the characteristic impedance of coaxial cable!

In the May issue of EA your discussion of measuring the impedance of coaxial cable jogged my memory. During the last war I spent six years in the English Air Force as a radar instructor. We always had rolls of co-ax laying around, and of course the labels got torn off — so we were never sure of the impedance of any roll of cable.

I devised a setup to do this easily. I applied a series of very narrow high frequency pulses to one end of the roll, with a 'scope also connected to this end of the roll. At the other end I connected a 100 ohm non-inductive carbon pot.

If the end of the cable was open, the pulse would travel down the cable and finding an open circuit, the energy would return as a pulse of the same polarity. It the cable was shorted and there was no resistance to dissipate the energy, a pulse would come back but of the opposite polarity.

By adjusting the pot, a value could be found that would match the impedance of the cable and the pulse would be dissipated and there would be no reflected pulse returned. Measure the resistance of the pot and you have the impedance of the cable. I hope you find this of interest. (Doug Thwaites VK4ADT, Esk Qld)

A simple method indeed, Doug. I presume the accuracy would depend on the sensitivity of the 'scope, as there would probably be a range of values for the pot that appear to give no reflection. But if you know the impedance of the cable is either 50 or 75 ohm, you would have no difficulty telling one from the other.

OC926, and thanks

As you can see from the next letter, this column gets results...

Please accept my grateful thanks for your kind assistance with regard to my request for information on transistor type OC926, a PNP silicon transistor for low frequencies (audio). I have had many responses from the readers of your magazine: Mr L Tuckerman advising a substitute (TT803) and Mr N Bush (NSW), also Mr W Woods, likewise Mr John Mallas of Tasmania and others. I am greatly indebted to all those who have responded to my request for assistance. (William Basterfield, Moorabbin, Vic)

We're glad to be of help, William. There's a wealth of information out there, and obviously quite a few people willing to help pass it on.

PC-based PLC

The next letter seeks advice on how to make a computer perform the function of a programmable logic controller (PLC).

I have an interest in what I believe is termed data acquisition hardware and software. That is, equipment and programs which enable a PC to operate as a PLC by accepting analog and digital inputs, processing this information by software and subsequently operating various output devices.

Can you tell me where I might find suppliers who handle such products, particularly for hobbyist budgets? Also do you know of any kits or projects that might suit this application? (Keith Cook, Cornubia, Qld)

A couple of suppliers come to mind, Keith. The first is Procon Technology, of PO Box 655, Mount Waverley 3149, phone (03) 9807 5660. We reviewed a range of products from Procon in the January 1994 issue, all of which are exactly what you are after. I can't tell if the prices are suitable, but the products are for an IBM compatible computer.

Another source is Oatley Electronics. In the May 1996 edition, there's a review of a computer driven relay interface, sold as a kit by this company. Although this is not enough to make a complete PLC from a computer, it provides four relays as outputs, which is a start. The kit price is $92 and includes software. Contact Oatley Electronics at PO Box 89, Oatley 2223, phone (02) 579 4985.

What??

The question this month has an interesting history. You might remember a monthly column 'Recreational Mathematics' in *Scientific American*, run by Martin Gardner. This column started in 1957, and was such a success it was kept going after Martin died. The question I'm posing is from a book called *Mathematical Puzzles and Diversions*, also by Martin Gardner, and was pointed out to me by *EA* colleague Graham Cattley.

An electrician is confronted with an interesting problem. Eleven unmarked wires run in a conduit from the basement of a building to the fifth floor. The wires are accessible only at each end of the conduit, and the electrician needs to identify each wire and label it at both ends.

Armed only with a simple continuity tester, and the inherent laziness that is part of every electrical technician, how can he achieve this task with the fewest trips up and down the stairs?

Answer to July's What

The answer is 1.5. You can see this by drawing the other diagonal of the rectangle. This diagonal is the radius of the circle, which was specified as 1.5. You either saw it or you didn't! ❖

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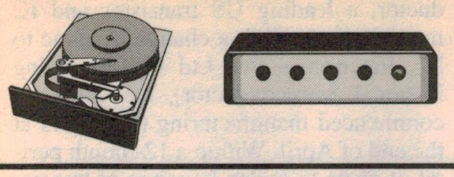


Experimenting with Electronics

(Continued from page 73)

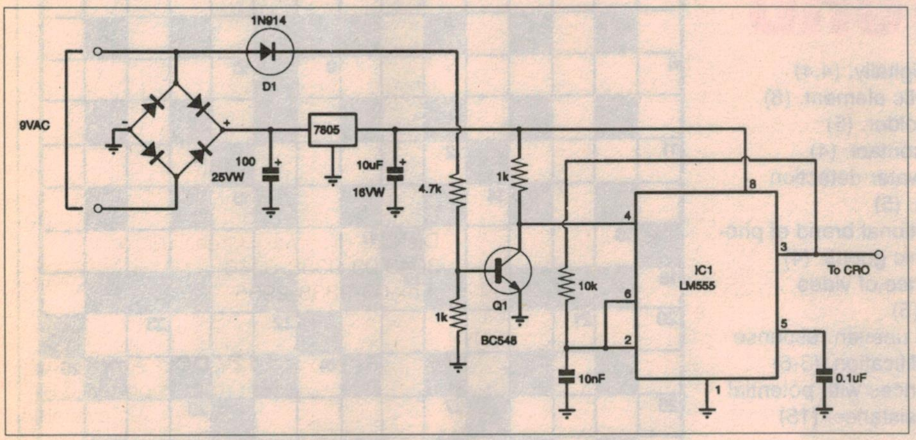


Fig.6: Use this circuit to generate a test signal for setting the frequency compensation of the scope probes and attenuators, and also for calibrating their timebase ranges.

Shown in Fig.6, this circuit produces a modulated digital waveform with two frequencies. The idea of a CRO calibrator is so that you can make sure that the edges of a square waveform are actually square and not rounded.

Most CROs have a calibrate (or frequency compensation) screw which you adjust once you've connected the internal frequency source up to the input.

If that signal source dies, you can easily substitute this instead. It uses the mains frequency to modulate the 555 timer running at a few kilohertz — the frequency is not all that important.

Looking at the circuit, power is derived from a 9V AC plug pack, which is rectified and turned into a smooth 5V DC source. This is used to power up the 555 timer, which is running in our reduced component count oscillator. The only difference in this circuit is that the reset at pin 4 is not tied to the supply rail. Instead, it is controlled by transistor Q1, which in turn is switched on during every positive half cycle from the AC mains via the 4.7kΩ resistor and diode D1.

Remembering that the 555 timer only works when pin 4 is held high, while ever the transistor is switched off, the 555 oscillates at a few thousand hertz. When the transistor is on, the output is low.

If you looked at this on a CRO, you'd see a gated waveform which would have components of the oscillator output as well as the mains frequency since it controls when the oscillator is on and off.

The 555 also has a good output stage which provides very good transitions from high to low and low to high, and is ideal for use with a CRO.

OK, so there you have a few more applications using the many different parts of the 555 timer. The great thing is that there are so many circuits using this IC, you're bound to find an interesting circuit or two in your travels.

Next month, we'll take our final look for the time being at this little IC, and have a look at a few more circuits. ❖

50 and 25 years ago...

'Electronics Australia' is one of the longest running technical publications in the world. We started as 'Wireless Weekly' in August 1922 and became 'Radio and Hobbies in Australia' in April 1939. The title was changed to 'Radio, Television and Hobbies' in February 1955 and finally, to 'Electronics Australia' in April 1965. Here we feature some items from past issues.

August 1946

Television pioneer dies: John Logie Baird, often referred to as the 'father of television', died on June 15. He was 58 years old. In 1924, he is credited with having produced the first television receiver and transmitter, capable of sending crude images by radio.

Undoubtedly science will remember him and his achievements. He will be remembered as a man who struggled with little outside help and encouragement, to make for himself a niche in the history of radio science, even though he merely applied devices which existed many years before his time.

Television from the Air: The recent atomic bomb tests at Bikini Atoll made use of robot planes fitted with television equipment, which relayed pictures of the scene to the watchers miles away.

Revolutionary television news coverage over long and short distances, from cars, boats, planes and helicopters is foreseen by Brigadier-General David Sarnoff, president of the Radio Corporation of America, as one of many possibilities opened by two systems of airborne television revealed to the public for the first time on March 21, in a joint Navy-RCA demonstration at the Navy Air Station, Anacostia, DC.

August 1971

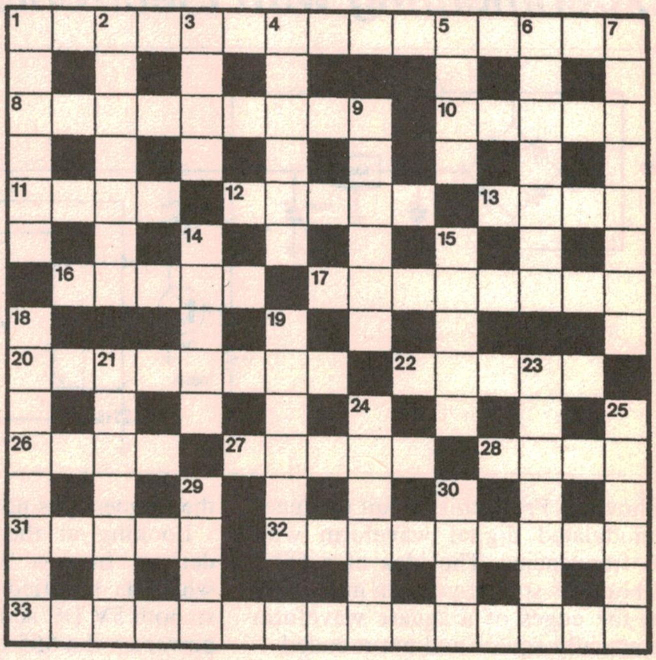
New Semiconductor Factory: A new $250,000 semiconductor plant has been opened at Bayswater, 15 miles out of Melbourne, by Rutherford Electronics, Australian agent for National Semiconductor, a leading US transistor and IC manufacturer. With a change in name to NS Electronics Pty Ltd (NS implying National Semiconductor), the company commenced manufacturing transistors at the end of April. Within a 12-month period, it plans to widen its range of transistors and commence IC production.

NS will not enter the high technology area of semiconductor manufacture. It will receive wafers after fabrication, and then complete the manufacturing process for both transistors and ICs. The total plant at Bayswater is 9260 sq ft, of which the production area is 6250 sq ft.

Colour circuit on two chips: Plessey Microelectronics in the UK has squeezed the entire colour signal processing circuits for a colour TV receiver onto just two chips. Stressing the magnitude of the achievement, a Plessey spokesman pointed out that by contrast some companies took five chips to do the job, and even this is considered advanced.

The circuits were custom designed for Rank Bush Murphy, and orders have been placed worth nearly £300,000 for an initial batch of circuits. The two chips provide chroma amplification, gated burst amplification with 45° switch, reference amp, PAL switch, colour killer, balanced demodulators and more. ❖

EA CROSSWORD



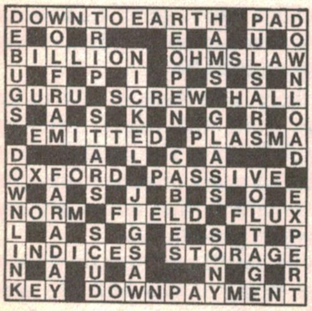
ACROSS

1 Communicating device. (6,9)
8 Fails to set in correct position. (9)
10 Type of control. (5)
11 Cut groove with power tool. (4)
12 Group of recordings. (5)
13 One's distinct Morse sending style. (4)
16 Brand of microwave oven, etc. (5)
17 Fifty, digitally. (4,4)
20 Synthetic element. (8)
22 Cord holder. (5)
26 Make contact. (4)
27 Underwater detection system. (5)
28 International brand of photographic goods. (4)
31 Sequence of video shots. (5)
32 Said of uneven response or amplification. (3-6)
33 Substances with potential zero resistance. (15)

DOWN

1 Storage facility. (6)
2 Element used in fusible alloys. (7)
3 Last in, last out. (4)
4 Type of switch. (6)
5 Proceed through a filter.(4)
6 Corrode. (7)
7 Charged particle. (8)
9 Recording room. (6)
14 Subject to infrared radiation. (5)
15 Parts of a tape recorder. (5)
18 Makes sequence of images for a cartoon. (8)
19 Type of burner. (6)
21 (Of signal) become indistinct. (5,2)
23 Spark generator. (7)
24 Constructed with cooling surfaces. (6)
25 Constellation. (6)
29 Operator of a PC. (4)
30 Compact form of information storage. (4)

SOLUTION TO JULY 1996:



Electronics Australia's

Professional Electronics

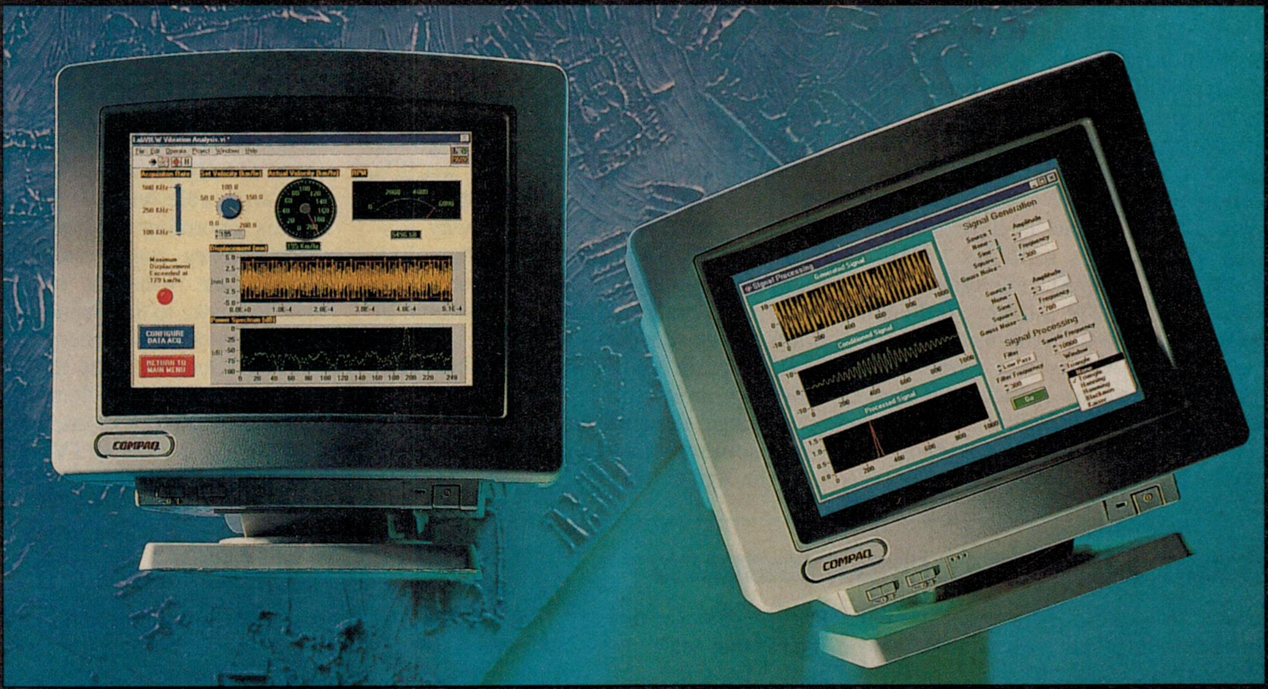
S•U•P•P•L•E•M•E•N•T

PHILIPS & NEC WIN $107M INDONESIAN CONTRACT FOR RADIO TELECOMMUNICATIONS

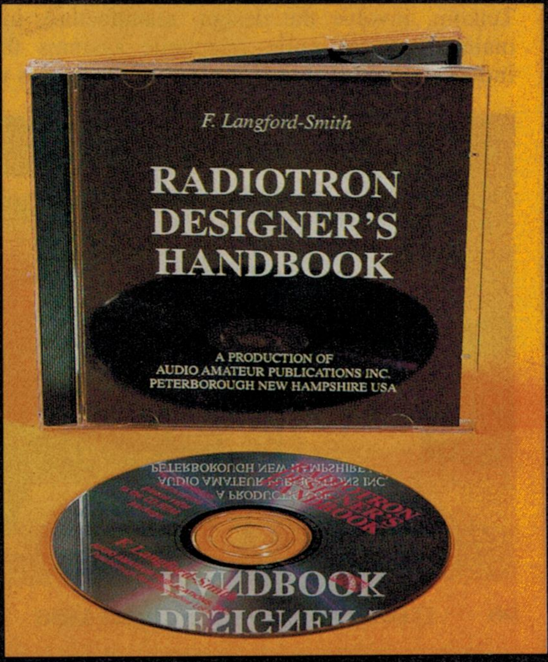
INTEL TESTING HIGH SPEED CABLE MODEMS — IN KOREA

BUILD A LOW COST 20MHZ FUNCTION GENERATOR USING THE MAX038 CHIP

TEXAS INSTRUMENTS CLAIMS LEAP IN CHIP TECHNOLOGY



NATIONAL INSTRUMENTS UPGRADES LABVIEW & LABWINDOWS, ALLOWING GRAPHICAL AND C PROGRAMMING TO BE COMBINED IN A SINGLE VIRTUAL INSTRUMENTATION SYSTEM...



FRITZ LANGFORD-SMITH'S CLASSIC *RADIOTRON DESIGNER'S HANDBOOK* NOW REPUBLISHED ON A CD-ROM!

NEWS HIGHLIGHTS

BUDGET CUTS COULD DAMAGE INDUSTRY

The Federal Government's proposed budget cuts to industry support programs are likely to damage the international competitiveness and export orientation of Australia's electronics and electrical industries, according to the Australian Electrical & Electronic Manufacturers' Association (AEEMA).

AEEMA has undertaken an in-depth analysis of the impact upon its members of the possible cuts or changes to industry support programs, such as the 150% tax concession for R&D, the EMDG Scheme, the Computer Bounty and the abolition of the DIFF scheme. It says the worst case scenario is a reduction in exports of $300 million, a fall in employment of 4000 and increased business costs of $180 million. Reductions in R&D could total $100 million.

The AEEMA says that while it supports the need to reduce the budget deficit, the Government must take a long term perspective in its expenditure reductions. It points out that industry has had to adjust to falling tariffs over the past decade, in an environment where micro-economic reform has been very limited as yet. To remove successful industry development programs prematurely will adversely impact industry competitiveness by restricting activities in the critically important areas of exports and R&D.

TELSTRA BUILDS LONGEST DIGITAL LINK SUPERHIGHWAY

Australia's Telstra has set a global record by completing the world's longest synchronous digital hierarchy (SDH) optical fibre superhighway system. The 5000km Perth to Brisbane link enables communications to travel across six states and territories in Australia, at almost the speed of light.

Telstra is also introducing this technology into its metropolitan interexchange network in all capital cities and some rural areas.

The link can carry telephony, facsimile, Internet access, television and data, and future communications such as stock market and travel transactions, banking, entertainment and betting and gaming services.

Mr Doug Campbell, Telstra's Network & Technology Managing Director, said Telstra had invested about $20 million in Siemens SDH transmission technology to ensure that Telstra's customers had a 100% reliable and high quality network.

"Australians not only have the longest 2.5Gb/s SDH transmission link in the world, but the reassurance that in the event of any fault to the equipment or cable, all traffic can be automatically routed to back-up equipment and cable without delay."

"This enormous engineering project, which crosses some vast desert areas, including the Nullarbor, has been made possible thanks to the technology supplied by our project partner, Siemens."

The 2.5Gb/s link has the capacity to carry up to 30,000 simultaneous two-way STD phone calls, 54 broadcast quality TV channels, or 240 Pay TV channels, or more than 250,000 data channels.

PHILIPS, NEC WIN INDONESIAN CONTRACTS

Two Australian-based companies, Philips Electronics Australia and NEC Australia, have won Indonesian telecommunications contracts worth $107 million. The contracts, awarded by the Indonesian telecommunications operator, PT Telkom, involve the design, manufacture, installation and maintenance of radio telephone systems throughout the Indonesian archipelago. The Philips contract is worth $64 million, and that to NEC $43 million.

The Philips contract covers 15 provinces and includes all of Sumatra's seven provinces as well as the eastern provinces of Irian Jaya, Maluku, Nusa Tenggara Barat, Nusa Tenggara Timor and four others in Sulawesi. Transmission towers up to 110m tall are to be built in 500 remote sites. Construction is to be completed within 24 months. The towers are to be built by Philips co-contractor PT Telesys Infotama of Bandung. Helicopters will be used in the site survey phase and to airlift the digital point-to-multi-point radio systems into some of the more remote and high altitude sites in eastern Indonesia. Traditional rafts will also be used to transport equipment.

The IRT-2000 system chosen by Telkom Indonesia is almost identical to the highly successful solar-powered rural telephone system Philips supplies to Telstra for use throughout outback Australia. The Philips network is expected to provide access to over 11,000 direct telephone and ISDN capable lines. Some 15% of the lines are to be reserved for public pay phones.

The Philips project is to be financed through a $12 million soft loan from the Australian Government's Development Import Finance Facility (DIFF), with additional funds on commercial terms from the government's Export Finance and Insurance Corporation (EFIC). Between 30 and 40 jobs will be created, with much of the manufacturing to be undertaken at the Philips plant at Moorebank in Sydney's west.

INTEL TESTING CABLE MODEMS IN KOREA

TriGem Computer and Intel Corporation have begun a new era of high-speed Internet browsing in Korea with the launch of a new technical training and support service provided by Intel Australia's Communications Products Centre, based in Sydney. TriGem and Intel are trialing 'Home Net' services based on Intel's cable modem technology. The trial delivers an Internet browsing capability up to three hundred times faster than existing 28.8kb/s modems, by using a cable television network and a cable modem connected to a home PC.

The trial marks Intel's first broadband technology trial in the Asia Pacific region, following the opening of the organisation's Communications Products Centre in February 1996. Intel's specialist broadband technology team is based in Sydney and will provide customer support and training throughout the trial from both Australia and within Korea.

"We are very pleased to announce the introduction of high speed Internet browsing in Korea", said Ms Teri Lasley, Manager of Intel's Asia Pacific Communications Products Centre. "The demand for high speed information transfer via the Internet is getting higher each day as the Internet user base grows", she added.

The first live Korean demonstration was demonstrated to end users on 3 May 1996, and the test will be conducted in schools, parliament and homes that have cable installed. The test service is to begin in the Yoido area of Seoul, where the cable service is provided by Hankang Cable TV Inc. After that, the service will be expanded to cover all the areas that have cable network established.

Four companies are taking part in the Home Net trial, each playing a different role. TriGem Computer will provide network technology while Intel, Hankang Cable TV and I-Net will provide cable modem technology, cable network and Internet technology respectively. Hankang Cable TV Inc., the system operator, is linked to the Internet server of I-Net using routers and head-end equipment which transfers data over the cable network.

TriGem's multimedia PC, which has built-in Internet link capability, will be able to deliver high speed interactive services including CATV, Internet browsing and VOD services. TriGem Computer was the first PC manufacturing company in South Korea, and still ranks as one of the largest.

NEW UHF BAND FOR CORDLESS PHONES

A further frequency band is now available for use by Cordless Telecommunications Services (CTS) in Australia.

Until recently, in addition to the basic cordless telephone services that operate in the bands 1.7/40MHz and 30/39MHz bands, provision was also made for CT2 and CT3 technologies in the bands 857 - 861MHz and 861 - 865MHz. In addition to these bands, the SMA has now opened up the 1.9GHz band for use by new technologies, thus providing a wider range of services.

To give effect to the additional frequency bands the Spectrum Manager recently made the 1.9GHz Band Plan, which makes provision for CTS to share the 1880 - 1900MHz band with existing fixed links. The new arrangements presently make allowance for CTS using the Digital Enhanced Cordless Telecommunications (DECT) technology, but the use of other technologies is likely to be possible, subject to their being able to co-exist in this band.

CTS systems can serve a number of low power short range mobile telecommunications applications, including Public Access Cordless Telecommunications Services (PACTS), wireless PABX, domestic cordless telephone services and wireless LAN. The operation of CTS in the new band is conditional on equipment complying with standards specified by the SMA. The SMA has initially specified the DECT standard (as adopted by AUSTEL in Technical Standard TS 028) for CTS equipment used in the 1.9GHz band. The SMA, in consultation with industry, is working on arrangements to establish that the band can also be shared with the Japanese Personal Handyphone (PHS) equipment.

WINNER OF GPS NAVIGATOR CONTEST

The May issue of *Electronics Australia* offered readers the opportunity to win a Magellan GPS 2000 Navigator, donated by Dick Smith Electronics. The compact handheld unit is valued at $595, and we asked readers to compete to see who could come up with the most imaginative and/or worthwhile use for it.

To be honest, we were swamped with entries — many hundreds had arrived at our office by the time for the judging, and selecting a winner was not easy. Some readers had even gone to the trouble of taking amusing or imaginative photos, to accompany their entry. We'd like to thank everyone involved for taking part in the competition, and making it such a success.

Alas, though, there could be only one winner. The entry finally selected by the judges came from Mr Stephen Jewell, of Goulburn in NSW.

Our congratulations to Mr Jewell, and his prize has been forwarded to him. We'd also like to thank Dick Smith Electronics, for donating the Magellan 2000 Navigator.

EAST COAST TO MAKE ARISTOCRAT PCBS

East Coast Printed Circuits, Australia's only PCB supplier with two quality accredited facilities, has won a competitive tender to produce 20,000 printed circuit boards for Aristrocrat Leisure Industries, to be used in the company's range of Aristocrat electronic gaming machines.

"This contract is evidence that East Coast is one of Australia's leading suppliers," said Mr Grant Evans, chairman of East Coast Printed Circuits. "We are proud to have been able to provide a competitive, realistic tender which serves Aristocrat's needs and proves our reputation for providing the most cost-effective result for order size," he added.

"Aristocrat machines are the standard-

setting and most popular machines of their type," said Mr Paul Ainsworth, corporate communications manager of Aristocrat Leisure Industries. "As another fully Australian-owned company, we are very pleased to be using East Coast Printed Circuits' products in these machines."

GAS & FUEL TRIALS REMOTE METER READING

Melbourne-based utility Gas & Fuel currently services and supplies gas to approximately 1.4 million residential, commercial and industrial users in Victoria. As with similar utilities the organisation has had an ongoing problem with an inability to gain access to meters at some premises. In late 1992, accounts based on estimates peaked at around 6% of the total number of accounts issued to residential customers, and one proposed solution to reduce these estimations was remote meter reading.

Remote meter reading does away with having to manually read meters, through the use of a variety of means. The most popular

method at the moment is radio, where data is transmitted by RF to either a hand held device or directly back to head office. Remote readings also protect meter readers from possible dangers, including dogs, and eliminates the need to bring equipment such as ladders to access meters which are located out of reach.

Initially, and after comprehensive testing, the Metering Centre chose the Hexagram hardwired remote meter reading system. Gas & Fuel installed around 1000 systems across Victoria, but following the news that the system may no longer be commercially available, the organisation turned to Itron — which was about to introduce its RF Off-site Meter Reading Systems (RF OMR) into Australia.

Upon arrival of the RF OMR system, Gas & Fuel placed an order for 500 ERT (encoder receiver transmitter) modules and commenced planning for a field trial to evaluate the suitability of the system.

An ERT is designed to encode consumption and tamper information on meters. When an ERT module receives an RF 'wake-up' signal, it begins transmitting this data back to a radio-equipped handheld computer or other unit.

If the field trial is successful, the RF OMR systems will be used in situations where access is a problem. However for the purposes of the trial access to a gas meter was required to allow for the comparison of RF versus manual readings, to determine accuracy and timing information.

S-A SERVICE CENTRE FOR SYDNEY

Communications technology specialist Scientific-Atlanta has established a new dedicated service centre in Australia. The new centre brings together service and support responsibilities previously dispersed throughout the local office, incorporating expanded repair facilities and a number of new control systems.

The service centre offers end-user support, training, product repair and spare parts service for both broadband products and satellite transmission products. In addition, it has been upgraded to support new technology such as Scientific-Atlanta's digital video compression decoders.

A new computer system, linked to Scientific-Atlanta's warehouse inventory system, tracks the progress of products in the centre for servicing. This system is also used to maintain a new service history database.

The centre currently supports Scientific-Atlanta's customers and a network of service agents in Australia and New Zealand. Plans are also underway to provide additional service and support to customers in Southeast Asia. Bradley Smith, formerly of Mitsubishi Electric, has been appointed service manager for the service centre.

CANBERRA LAB FOR MILITARY COMMUNICATIONS

The Defence Science and Technology Organisation (DSTO) has taken the first step towards making RAN, RAAF and Army command and control (C2) systems interoperable, by establishing a dedicated research and development laboratory in Canberra.

The Command and Control Information Systems Interoperability Laboratory (CCISIL) will enable Australian Defence Force (ADF) personnel to evaluate architectural, interoperability and portability issues associated with C2 systems. It will define the mechanisms and infrastructure of a common operating environment which each of the major Command, Control and Information systems projects will specify as standard. CCISIL will also contribute to development plans for the required levels of functionality and the seamless electronic exchange of information between C2 systems.

Further, DSTO will use the laboratory to demonstrate ideas for command, control, communications and intelligence (C3I) systems to the Australian Defence Force.

Under the Defence Preferred Systems Integrator Panel, DSTO has awarded CSC Australia a contract to carry out a range of projects associated with establishing and running CCISIL.

Dr Warren Harch, Research Leader C3, for DSTO, said: "The Army, RAN and RAAF have designed and developed their own command and control systems, because they know their requirements and possess the requisite knowledge. However, the inability of the systems to communicate with each other has long been an obstacle to exchanging information."

"Recent advances in computer and communications technology have created an opportunity to make command and control systems interoperable. The laboratory will enable DSTO to carry out research in C3 issues and members of the ADF

will assess the feasibility of having their command and control system communicate with others."

"Desert Storm proved that Defence forces with access to the latest information and intelligence have a tremendous advantage because they are able to get inside their opponent's decision loop."

Under the contract awarded by DSTO, CSC Australia is installing networks in the laboratory, comprising 10BaseT and fibreoptic Ethernet local area networks, Ethernet switched hubs and ATM switches. CSC is also responsible for installing file servers and workstations, together with software.

In the USA, CSC manages a number of similar laboratories for the US Department of Defense.

TAIT WINS $2.4M QLD RAIL CONTRACT

New Zealand-based Tait Electronics has teamed up with Brisbane specialist in Global Positioning Systems (GPS) Spectralink, to win a $2.4 million contract for a radio system which will use satellites to track and control trains on Queensland Rail's statewide network.

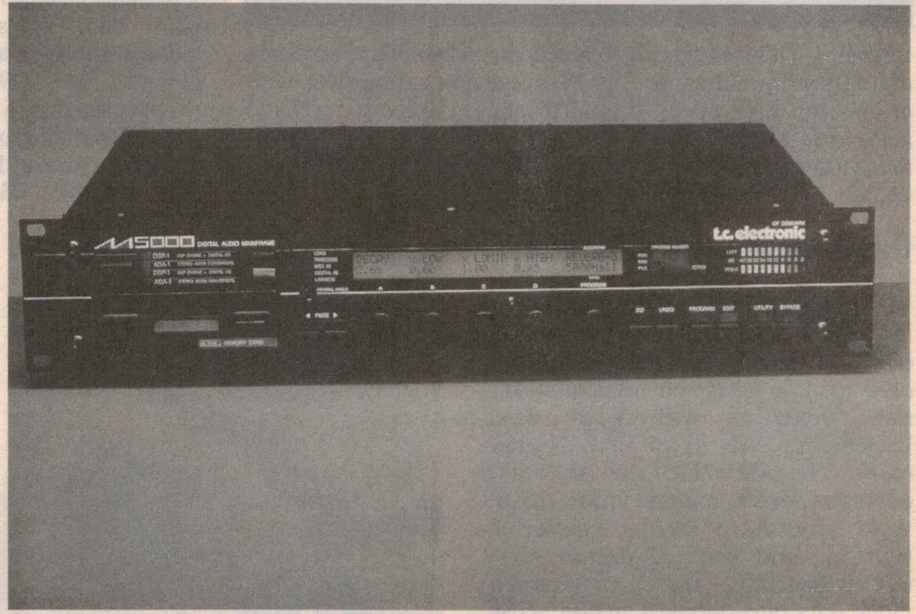
One of Tait's largest Australian contracts, it involves the design and supply of a combined communications-and-location mobile radio hardware package, which will cover Queensland Rail's 10,000 kilometres of track throughout the state. The concept is based on dividing the State into approximately 80 rectangular zones defined by geographical co-ordinates. Each of these zones contains a multi-channel base radio infrastructure connected to train control.

The system will enhance communications on the Queensland Rail network, ensuring radios automatically change to the correct channel for the zone of operations. This will give continuous communication without driver intervention, and enable Queensland Rail to instantly determine the location of any of its trains anywhere on its rail network.

The system hardware will consist of 1190 Tait T2020 UHF Mobiles with GPS data interface, and GPS receivers with integrated data modems. The sophisticated controller for the GPS system is to be designed and built by Spectralink.

The project will be managed by Tait's systems division, based in Brisbane. Expected to be operating early in 1997, equipment will be installed in all 528 locomotives and 130 Brisbane suburban trains.

DIGITAL AUDIO GEAR FOR OPTUS VISION



Optus Vision has installed two TC Electronic M5000 digital audio mainframes at its Video Operations Centre in Sydney. The M5000 units are used exclusively for digital audio compression and limiting, for Optus Vision's national cable television service.

The TC Electronic M5000 is a new generation digital signal processor which has rapidly gained acceptance among audio professionals throughout the world. The M5000 provides four independent two-channel processing modules in only two rack spaces, complete with an internal 1.44MB floppy disk drive and PCMCIA memory card slot. Each module provides true stereo DSP with 99 factory preset programs for reverberation, delays, delay-based effects and sampling, in a variety of analog or digital I/O formats. The M5000 may be operated with just one module or all four, for eight channels of DSP with independent AES/EBU, S/PDIF and Optical inputs and outputs.

The Optus Vision M5000 systems are both configured with four stereo DSP modules, all with digital I/O, giving a total of eight stereo channels of digital signal processing.

"Operating exclusively within the digital domain, we required digital broadcast compression and limiting processors for our movie and sports cable channels", says Stephen Hope of Optus Vision. "Some of our programme material, particularly digitally mixed movies, has a wider audio dynamic range than a broadcast transmission system can handle. The M5000's dynamics package offers a comprehensive array of parameters, including the ability to split the audio spectrum into three user-specified bands and apply differing dynamics to each band. It operates in an extremely transparent manner — we know it's working, but can't hear the usual pumping or breathing artifacts associated with conventional processors."

Inserted at the end of the signal chain just prior to national distribution, each of the eight stereo channels is dedicated to a specific programme channel. ❖

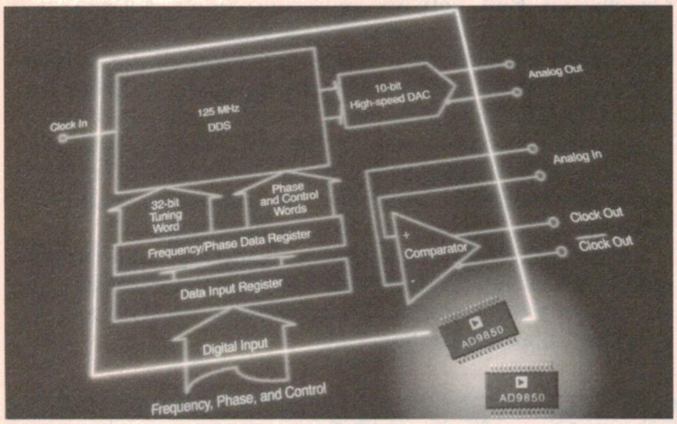
NEWS BRIEFS

- The first ***Home Entertainment Exhibition*** is being held at the Darling Harbour Convention and Exhibition Centre, November 8-10, 1996.
- ***Intelligent Systems*** has released its latest catalog on floppy disk. It contains details of industrial computer products. Phone (03) 9796 2290 for more information.
- The 13th International Electronics Industry Testing Equipment and Instrument Exhibition for Asia ***EII '96*** will be staged at the International Trademart, Hong Kong, August 8-10, 1996.
- Softbank COMDEX and CEMA have announced the creation of ***Interactive Content World***, a trade show promoting next-generation technologies and communications. It will run concurrently with COMDEX/Spring and Spring CES '97 in Atlanta, Georgia at the Georgia World Congress Center, June 2-5, 1997. Contact Softbank/COMDEX in the US (617) 433 1755 for details.
- The inaugural ***Cards Australia '96*** show focusing on plastic cards will be held at the Darling Harbour Convention and Exhibition Centre, August 20-22, 1996. ❖

Solid State Update

KEEPING YOU INFORMED ON THE LATEST DEVELOPMENTS IN SEMICONDUCTOR TECHNOLOGY

Programmable synth & clock generator



Analog Devices has introduced the AD9850, a 125MHz digitally programmable CMOS frequency synthesiser with an on-chip high speed digital to analog converter (DAC) and comparator. The device can be used as a high-performance numerically controlled oscillator (NCO) or as a frequency or phase-agile clock generator.

Communications applications include frequency-hopping local oscillators, digital phase modulation, and transmitter clock regeneration in spread-spectrum receivers. Markets include wireless local loop, satellite receivers, hybrid fibre cable data modems, radio frequency identification (RFID), and communications instrumentation.

The device features a 125MHz NCO with 32-bit tuning word, a 10-bit DAC, and a high-speed, low jitter comparator. Its programmable output frequency range is 42MHz and the IC takes 280mW from a +3.3V supply. The output sinewave delivers spurious-free dynamic range (SFDR) performance of greater than 50dB at 42MHz out and greater than 60dB at 10MHz out.

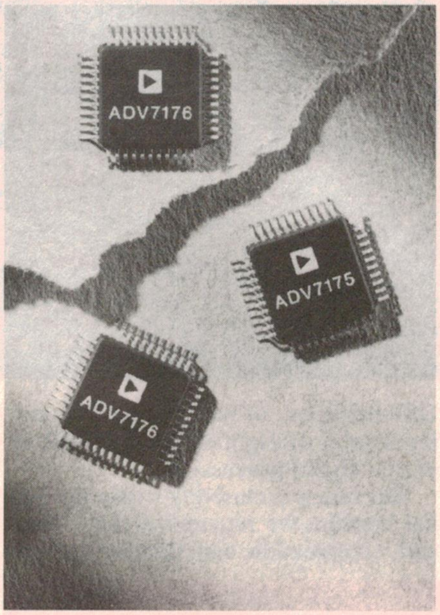
The output can be used directly as a sine source, or externally filtered and converted to a square wave via the device's internal high-speed comparator. The output frequency (and/or phase) can be digitally changed at a rate of up to 23 million new frequencies (phase shifts) per second. The 40-bit frequency/phase control update word is fed to the device as a digital code (parallel or serial input). The AD9850 is packaged in a 28-pin SSOP package and operates from a single +3.3V or +5V power supply.

For further information circle 276 on the reader service coupon or contact Analog Devices, PO Box 98, West Rosebud 3940; phone (059) 86 7755.

Digital video encoder ICs

Analog Devices has introduced two integrated digital video encoders, to convert digital video data into standard analog baseband television signals compatible with NTSC, PAL B/D/G/H/I, PAL M or PAL N standards. The ADV7175 and ADV7176 encoders each include four 10-bit video digital to analog converters (DACs), and convert digital YUV (CCIR-601/656 4:2:2) component video data into standard analog NTSC and PAL signals. The ICs also produce RGB, S-video (Y/C) and YUV analog video signals.

Housed in a 44-pin PQFP package, the devices provide 10-bit resolution for encoded video channels, programmable NTSC/PAL digital filters with low-pass and notch characteristics, and complete on-chip timing generation (via a master/slave mode operation). Digital video applications include TV set-top boxes, CD video players, digital video discs, desktop PC video, professional broadcast and studio video equipment.



The encoders provide an industry-standard CCIR-601 or DI digital input port. In addition, an extensive number of timing modes and configurations are included, enabling a glueless interface to all standard MPEG 1 and MPEG 2 video encoders. Other features for set-top box applications include the Macrovision anti-copy protection (ADV7175), close-captioning and Teletext support.

For further information circle 275 on the reader service coupon or contact Analog Devices, PO Box 98, West Rosebud 3940; phone (059) 86 7755.

DC-DC converter IC

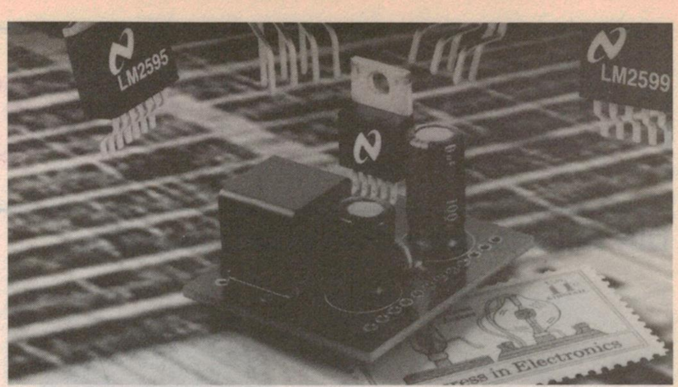
National Semiconductor has released the LM2825 Simple Switcher IC, claimed to be the industry's first single IC DC-DC power converter. This has been achieved by integrating the functionality of the four external components needed for DC-DC conversion. The device is packaged in a standard 24-pin case, which eliminates the need for a heatsink.

As a member of National's Simple Switcher family of power converters, the LM2825 expands the original combination of software design support, external component directories and guaranteed circuit performance, by integrating the external components typically necessary for DC-DC conversion circuits. As a single package operating free of external components, the IC can be designed into a system without using reference designs, vendor listings or other design aids.

The device is designed for step-down (buck) conversion, supplying up to 1A for 3.3V and 5V systems. Adjustable and 12V versions will be released later this year.

For further information circle 272 on the reader service coupon or contact National Semiconductor (Aust), Business Park Drive, Monash Business Park, Notting Hill 3168; phone (03) 9558 9999.

Step-down voltage converters



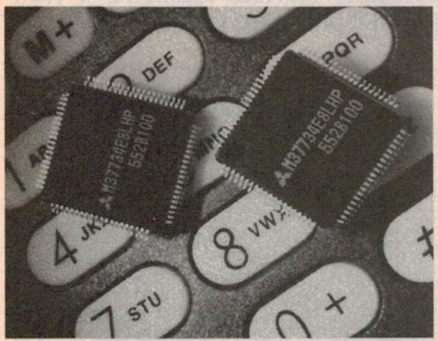
Four new step-down voltage converters have been added to National Semiconductor's line of Simple Switcher power converters. The devices operate at 150kHz, which allows the use of smaller external passive devices. Designated LM2595 and LM2598 for 1A operation and LM2596 and LM2599 for 3A operation, the regulators are offered in T0-220 packages and T0-263 surface-mount packages.

The new converters are supported by Switchers Made Simple design software, which provides a complete design solution including schematics, component lists and vendor information. National guarantees system performance for DC-DC converter applications designed using the components listed in either the company's design software or data sheets.

Optional features, available only for the LM2598 and LM2599, include a power-on reset indicator with user programmable delay; an out-of-regulation flag that indicates below tolerance voltages; and a softstart feature to prevent excessive in-rush current. All four ICs offer external shutdown and self-protection features such as current limiting and over-temperature shutdown and are currently available in 3.3V, 5V, 12V and adjustable-output voltages. Maximum input voltage is 40V.

For further information circle 278 on the reader service coupon or contact National Semiconductor (Aust), Business Park Drive, Monash Business Park, Notting Hill 3168; phone (03) 9558 9999.

Low power microcontrollers



Mitsubishi Electric has announced a new range of 16-bit microcontrollers for DECT and portable communications applications, office automation and computer peripherals. The range comprises the M37733, -34 and -35, and features direct output external bus signalling and a built-in 32kHz dual clock.

The microcontrollers are based on the proven 7700 series core, and incorporate a CPU and bus interface unit. The devices can also operate in 8-bit mode. The M37734 provides 160ns execution at 25MHz and incorporates 103 basic instructions. It has 60KB of ROM, 2048 bytes of RAM, operates from a single 5V supply and dissipates 95mW at 25MHz.

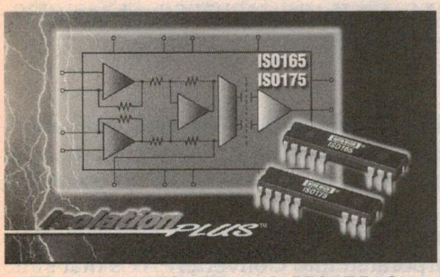
Added features to the range include chip select and read/write signal outputs, together with an ADC Vref input shut-off function, which allows the operating current to be further reduced. There's also a wake-up interrupt function.

On-chip features include 19 interrupt types at seven priority levels, eight 16-bit timers, a 16-bit multifunction timer, two UARTs, an 8-bit A-D converter, 68 programmable I/Os and a 12-bit watchdog timer. The M37734 microcontroller also features improved power saving modes.

The '33 and '35 microcontrollers incorporate all the functions and design specifications of the M37734, and are upwardly compatible with it. They additionally incorporate three serial I/Os, a 10-bit A-D converter, 124KB of ROM and 3.9KB of RAM. The operating current for the '33 and '35 versions is typically 20% lower than for the M37734.

For further information circle 277 on the reader service coupon or contact Mitsubishi Electric Australia, 348 Victoria Road, Rydalmere 2116; phone (02) 684 7777.

Isolated instrument amps



The new IS0165 and IS0175 from Burr-Brown are precision, input isolated instrumentation amplifiers that use a unique duty cycle modulation-demodulation technique, claimed to give excellent accuracy. A single external resistor sets the gain anywhere from unity to 10,000. Both amplifiers are rated at 1500V RMS continuous, and 2500V RMS for one minute. The internal input protection can withstand up to +/-40V. Applications include power monitoring, medical instrumentation, analytical and biomedical measurements, data acquisition systems and test equipment.

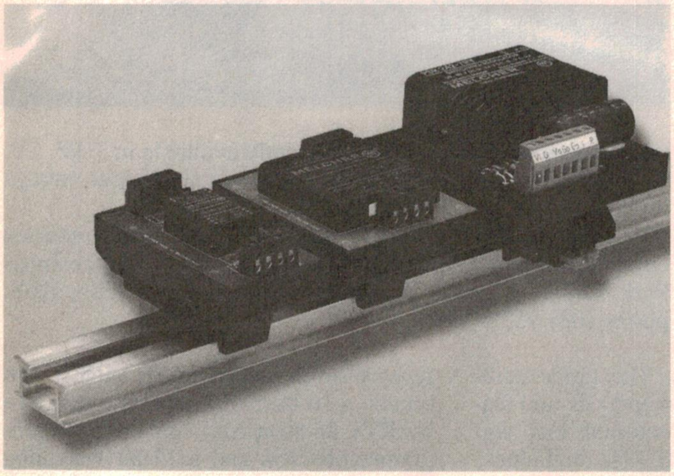
Signals are transmitted digitally across a differential capacitive barrier. With digital modulation, barrier characteristics do not affect signal integrity, which results in excellent reliability and good high frequency transient immunity across the barrier.

Key specifications include 115dB at 60kHz IMR, +/-0.05% nonlinearity (IS0165), 10nA input bias current, +/-4.5V to +/-18V power supply range, 125uV input offset voltage and an output voltage of +/-10V bipolar operation. The ICs are available in a 24-pin plastic 'skinny' DIP, and are specified over the -40°C to +85°C operating temperature range.

For further information circle 271 on the reader service coupon or contact Kenelec, 2 Apollo Court, Blackburn 3130; phone (03) 9878 2700. ❖

NEW PRODUCTS

DIN rail/chassis mount power supplies



Melcher now has power supplies for DIN rail or chassis mounting in a cabinet or on a wall. Various families of Melcher's AC-DC and DC-DC converters, for a power range of one to 150W, with outputs providing one to three output voltages of up to 48V DC can be fitted directly onto a DIN rail with mounting accessories. Screw-type or plug-in connections are available.

The units are prepared with the necessary screw holes for mounting in a chassis or on a wall. If the screw connection is only accessible from the front, adapter plates are available which permit fixing from the front.

For PCB mount, DC-DC converters are also available in the three to 15W power range with fitting sets for DIN rail or direct chassis mounting. Depending on the type of regulator and application, additional filter components can be fitted on the printed-circuit board.

For further information circle 243 on the reader service coupon or contact Scientific Devices Australia, 2 Jacks Road, South Oakleigh 3167; phone (03) 9579 3622.

Miniature DC motor system is modular

A new DC motor modular system, called the RE026, has been recently released by Interelectric AG under the Maxon Motor name. Employing the company's patented moving coil rotor, the RE026 has an outside diameter of 26mm.

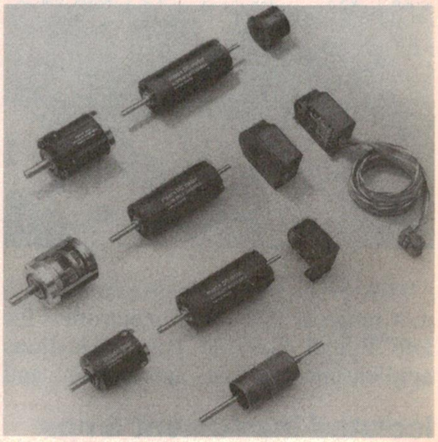
Modular in concept, it has a power rating of 18W. This high output power is because the motor uses a Neodymium magnet. It has graphite brushes and a mechanical time constant of only 5ms.

Three different precision planetary gearheads are available within the modular system. Also available is a DC tacho with an output voltage of O.5V per 1000rpm for simple speed control.

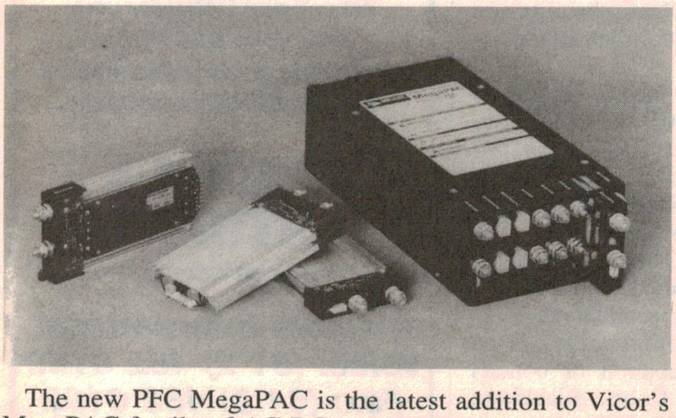
For exact positioning, a digital encoder is available which provides 100 to 1000 counts per turn. In two or three channel versions, phase shifted, the encoder is also available with line driver.

The RE026 is part of Maxon's range of high performance, low inertia drives which employ the CLL concept (capacitor long life) technology, claimed to give a significant extension to the working life of the motor.

For further information circle 247 on the reader service coupon or contact M. Rutty & Co., 4 Beaumont Rd, Mount Kuring-gai 2080; phone (020) 457 2222.



Configurable power supply



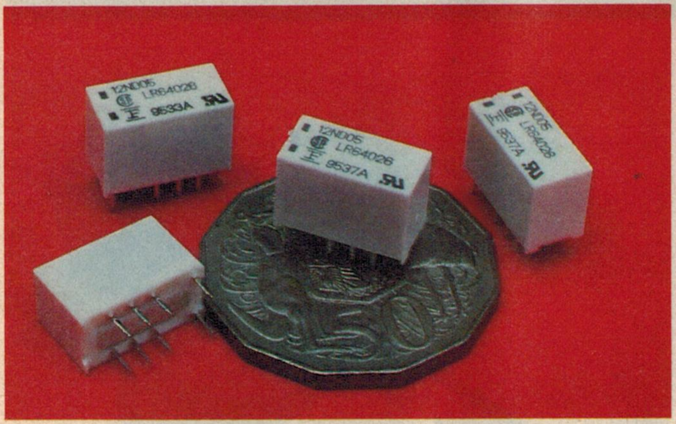
The new PFC MegaPAC is the latest addition to Vicor's MegaPAC family of AC-DC and DC-DC switching power supplies. It has a field configurable, universal AC input switching power supply with near-unity power factor, and provides from one to 16 outputs, up to 1600W. It measures 302 x 152 x 86mm.

The outputs are configured using standard Vicor components, which are incorporated into ConverterPACs that slide into MegaPAC chassis slots. These assemblies can be added or replaced on-site. The power from individual ConverterPACs can be combined for higher power outputs, and entire MegaPACs can be connected in parallel to increase the output power.

Features of the family include EMI/RFI filtering, output sequencing, an input power fail signal, an output power good signal, local and remote sensing and output overcurrent protection.

For further information circle 241 on the reader service coupon or contact Powerbox Australia, 4 Beaumont Rd., Mt Kuring-Gai 2080; phone (02) 457 2200.

Micro relay has low coil power



IRH Components has released the Fujitsu FBR10 series of DPDT microminiature relays for telecom and signal switching applications. The relays have a dual-in-line terminal pitch and measure 14.6 x 7.2 x 10mm.

Permanent magnet assisted armature operation results in a coil power dissipation of 140mW at the rated coil voltage (85mW pick up). The bifurcated DPDT gold-clad contacts are rated at 2A, 30V DC (resistive) and are suitable for low level switching applications. A range of coil voltages from 3V to 24V DC is available. The relays are fully sealed for automatic soldering and immersion cleaning.

For further information circle 245 on the reader service coupon or contact IRH Components, Locked Bag 103, Silverwater 2128; phone (02) 364 1766.

RF current immunity tester

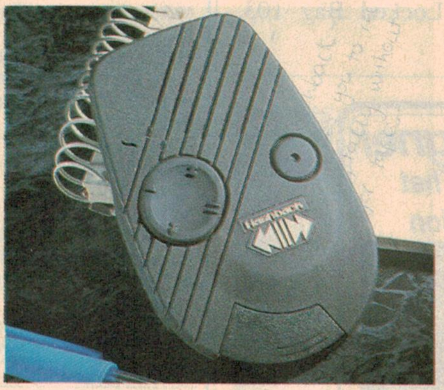
The Schaffner NSG420 is an instrument for electromagnetic immunity testing to IEC 1000-4-3/801-3, as well as precompliance testing for IEC 1000-4-6/801-6. It is suitable for development, test and production applications.

A wide-band RF frequency source provides a 'comb' spectrum signal which is injected into one of the conductors of the device under test (DUT) by means of a clamp-on current transformer. The instrument's signal can be AM or FM modulated with synchronisation to other test equipment or, under external command, it can provide spot or sweep-modulated frequencies. Below 300MHz, current injection testing generally provides higher reproducibility than can be achieved with radiation testing, where conductor position can be critical.

The instrument is palm-sized, battery-operated, has an integral two-part transverse slot current transformer to accommodate cable to the DUT, a LED bar display indicating RF power in dBuA, internal 1kHz modulation oscillator, modulation connector for synchronisation, output level control and DC-level remote monitor output.

For further information circle 242 on the reader service coupon or contact Westinghouse Industrial Products, Locked Bag 66, South Melbourne 3205; phone (03) 9676 8888.

Handheld digital audio recorder



New to Dick Smith Electronics is the Flashback digital recorder, claimed as the only hand held recorder on the market capable of recording up to 18 minutes of speech. The unit is smaller than a pack of cards and weighs around 85 grams.

Because it uses digital technology, users can record messages on a continuous basis as well as adding messages during any stage of the recording, without recording over previous sections, (like inserting text in a word-processor). As well, like a compact disc, the unit allows instant access to sections of recordings by enabling users to mark any part of the recording with the press of a button.

Claimed as the newest innovation to hit the corporate executive market in some time, Dick Smith Electronics believes this product will appeal to journalists, executives, students and the pre-existing Dictaphone market. It will also suit those who record interviews, meetings and lectures.

It operates from two AAA batteries and is PCMCIA compatible, allowing users to download recordings from the unit to a computer or PDA. It is impervious to magnetic fields and temperature changes, and can be recorded over with consistent voice reproduction up to 10,000 times, compared to 200 times on a standard tape.

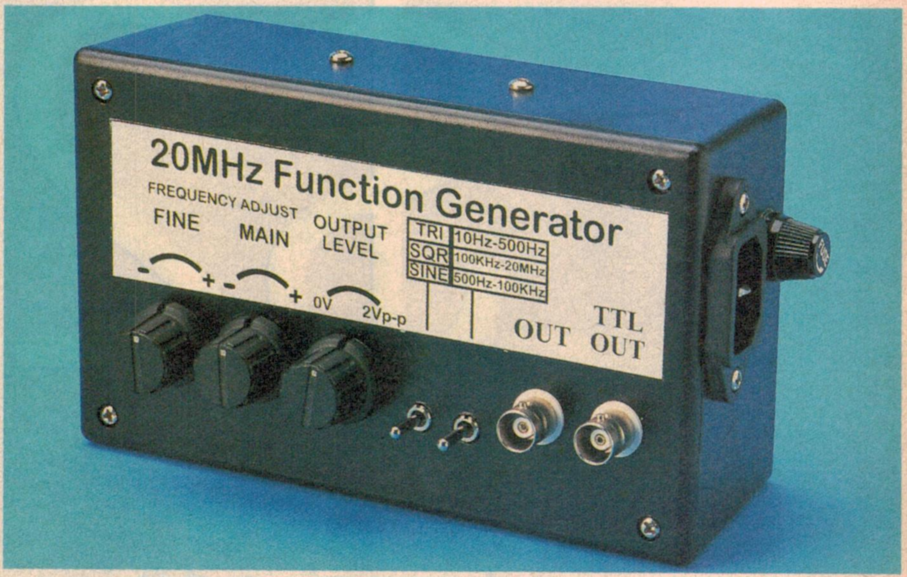
Features include simple one-touch recording operation and a unique 'lock' feature which protects information from access or accidental deletion. Also available is an additional 36-minute sound clip for $99. The recorder is priced at $299 (includes one 18-minute soundclip) and is available all Dick Smith Electronics stores.

For further information contact your nearest Dick Smith Electronics sales outlet. ❖

Low cost 20MHz Function Generator

Most of the function generators available either as kits or 'affordable' commercial units have a maximum useable frequency of about 2MHz. Here's the design for a unit which goes to beyond 20MHz, yet can be built for less than $100. Thanks to a powerful new chip from Maxim, it's also very easy to put together...

by DAVID L. JONES



I thought I had a relatively well equipped work bench, up until a couple of months ago when I wanted to test some op-amp circuits for a new design. They needed to work to at several megahertz, and it would have been nice to test them at over 10MHz. However, it soon all came to a halt when I remembered that both of my function generators were only capable of a little over 1MHz. I did have access to some expensive commercial digitally synthesised function generators capable of providing over 10MHz, but I wanted a simple and low cost one for my own bench!

Want being the mother of invention, I put my current design aside for a while (as usual!) and decided that I needed to build a high speed function generator.

The first thing I did was to look for any previous function generator projects that might meet my requirements. The only one that catered for frequencies in the MHz region was the digitally synthesised design published in the April 1993 edition of *EA*. Whilst it did handle the frequency I needed, I wanted something with real *knobs* that could be easily adjusted...

The design was starting to look terribly complicated, when along came the MAX038 chip from Maxim Integrated Products in the United States. This provides a complete 20MHz sine/square/triangle function generator in a single chip!

While it is possible to build a complete function generator using just the MAX038 and a few capacitors and resistors, I found that it needed just a little bit more circuitry to make it into a fully fledged function generator design.

The final design described here is capable of producing sine, square, triangle and TTL level waveforms at up to and beyond 20MHz. See the accompanying table for full specifications.

Normally, an analog function generator capable of this frequency range would be very expensive and very complex. But as you can see, this entire design consists of little more than three IC's!

Please note that this project has been designed for the highest possible frequency coverage, and NOT for the lowest possible distortion level. With a sine wave harmonic distortion of greater than 1%, it is not suited for precision audio applications. But at the same time it should be fine for general audio use.

The MAX038 was originally quite hard to obtain in Australia, but it is now stocked by RS Components and is quite readily obtainable. The performance of the MAX038 does not come cheaply, though — the chip is priced at almost $50. However considering the specifications of the device, it is still the lowest cost way to get a function generator in this frequency range.

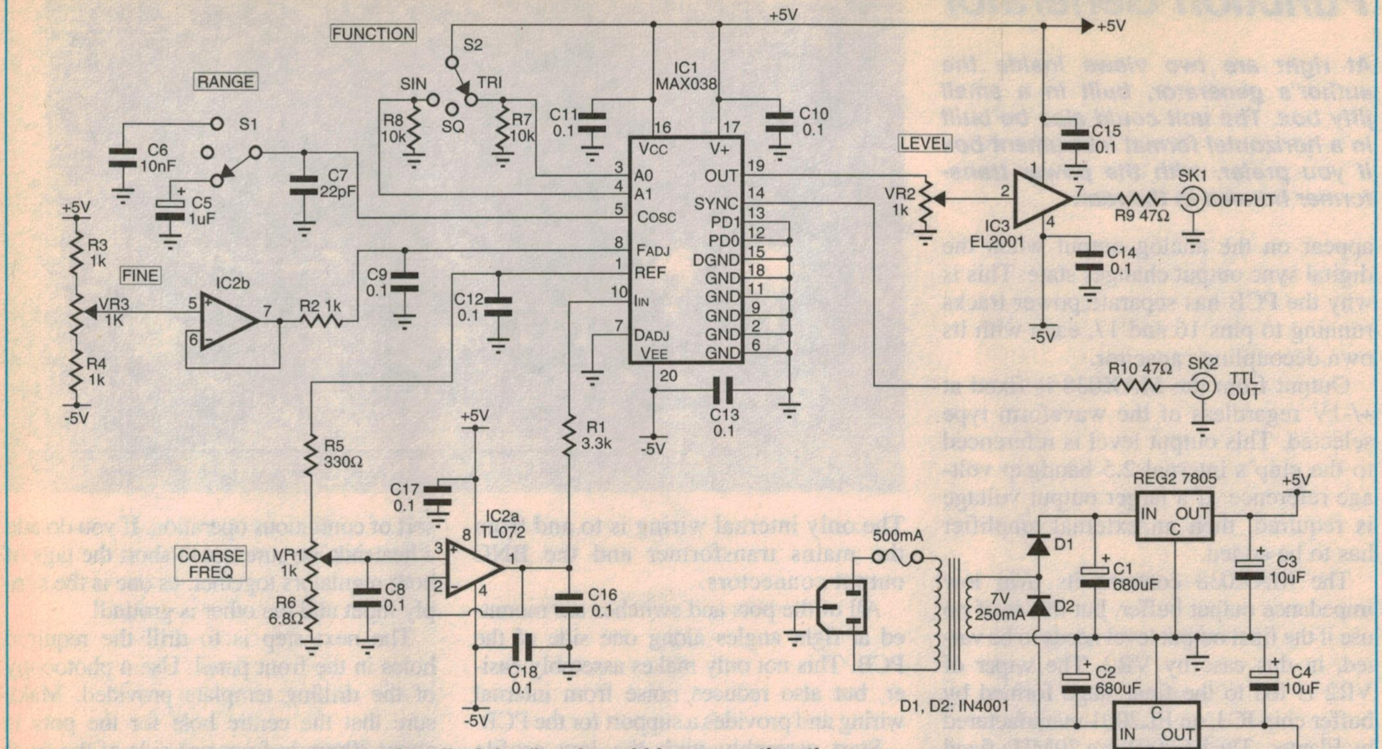
To keep the cost of the unit to the absolute minimum, it was decided not to include a frequency display. It is assumed that the unit will be used in conjunction with a frequency counter or an oscilloscope. (The EA Frequency Counter design published in February 93 would be an ideal low cost solution for this.) Other features such as duty cycle adjustment and modulation inputs have also been omitted, for the same reason.

Inside the MAX038

Surprisingly, the MAX038 does not use any fancy or patented circuit techniques to produce frequencies up to and beyond 20MHz. Instead it uses a simple relaxation type oscillator that operates by charging and discharging a capacitor (on pin 5), using a constant current. It is basically a dual-slope integrator that produces a triangle wave, the frequency of which is determined by the external oscillator capacitor and the input current at the 'IIN' pin (pin 10).

This internal triangle wave is fed into an internal comparator, to produce the square wave function. The sine wave function is produced by feeding the triangle wave into a sine wave shaping circuit that automatically corrects for the desired frequency, and produces a reasonably low distortion sine wave at a constant amplitude.

The sine, square, and triangle waves are then fed into a multiplexer that



As you can see from the schematic, all of the 'hard work' in generating the waveforms is done by IC1— a MAX038 chip from Maxim.

selects which function to output to the low impedance output buffer.

Circuit details

The MAX038 does all of the work in generating the actual waveform, so all we have to do is to tell it which frequency to operate at, and which type of waveform (sine/square/triangle) to produce.

The output frequency is determined by three factors. The first one is the value of the oscillator capacitor on pin 5, which sets the frequency range that the chip will operate within. The second factor is the current fed into Current Input IIN, while the third is the voltage applied to the Frequency Adjust 'FADJ' input (pin 8).

Somewhat contrary to its name, the Frequency Adjust pin is not the best way to adjust the output frequency. The output frequency is actually directly proportional to the current going into the IIN pin. The FADJ input is merely used for finer frequency adjustment (or for frequency modulation), as it only has about 70% of the adjustment range of IIN.

To adjust the output frequency, the current fed into IIN can range from approximately 2 microamps to 700uA. The IIN pin acts as a virtual ground, and thus it is a simple matter of applying a positive voltage via a resistor to IIN. This produces a current into IIN which can be simply worked out using Ohm's law. In fact, the output frequency can be related by the simple formula:

Fo (MHz) = IIN(uA)/Cf(pF)

Where Cf is the value of the oscillator capacitor on pin 5. This formula assumes that FADJ is at zero volts.

The buffer circuit formed by IC2a is used to provide a stable voltage reference to drive the current input pin IIN. This also allows use of a low value pot (VR1) for the main frequency adjustment. An on-chip 2.5V bandgap voltage reference (IC1 pin 1) is fed into the voltage divider arrangement of R5, VR1, and R6. Stopper resistors R5 and R6 stop the value of IIN from going outside of its allowable linear range.

Fine frequency adjustment is achieved by varying the voltage on the FADJ pin. Unlike the IIN pin, the FADJ pin works by varying the input voltage up to plus or minus two volts. In this circuit, the range is set to +/-1.6V by the voltage divider action of R3, R4, and VR3. IC2b then buffers the voltage, which goes to the FADJ pin via the low-pass filter of R2 and C7.

The three frequency ranges are selected by range switch S1. This simply parallels C5 or C6 across C7 to give the low and medium ranges respectively. For the highest range, only C7 is connected in circuit.

The sine, square or triangle functions are selected by S2. A0 (pin 3) and A1 (pin 4) are digital select inputs which select via an internal mutiplexer either the sine, square or triangle waveform to be fed to the output.

The digital TTL output is taken directly from the SYNC output on pin 14. This output changes from low to high when the analog output crosses zero volts, going positive. This can be used to synchronise the analog output to some circuit under test, or to trigger a scope; however its main use is just as a standalone TTL level output.

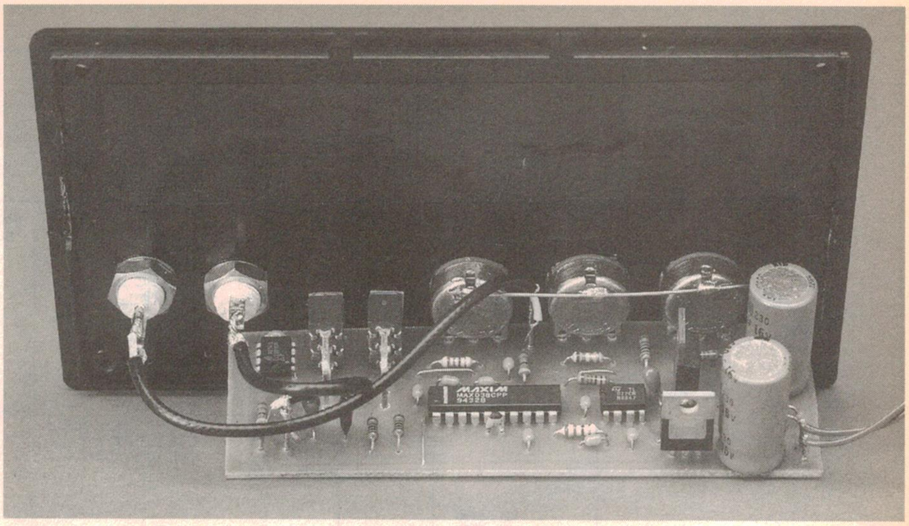
The SYNC output has its own supply pin (pin 16) that has to be decoupled from the main analog power supply on pin 17, otherwise a small 'spike' will

SPECIFICATIONS

Output Functions:	Sine/Square/Triangle/TTL
Frequency Range:	Sine 10Hz — 20MHz
	Square 10Hz — 10MHz
	Triangle 10Hz — 10MHz
Sinewave Distortion:	Typically <2%
Squarewave Rise/Fall Times:	<10ns
Output Voltage Level (All ranges):	0-2Vp-p
Frequency Ranges (All Functions):	
LOW	10 — 500Hz
MED	500Hz — 100kHz
HIGH	100kHz — 20MHz
TTL Output:	TTL voltage level
(Synchronised with analog output zero crossing)	
Output Impedance:	Nominally 50 ohms

Function Generator

At right are two views inside the author's generator, built in a small jiffy box. The unit could also be built in a horizontal format instrument box if you prefer, with the power transformer housed in the rear.



appear on the analog output when the digital sync output changes state. This is why the PCB has separate power tracks running to pins 16 and 17, each with its own decoupling capacitor.

Output from the MAX038 is fixed at +/-1V regardless of the waveform type selected. This output level is referenced to the chip's internal 2.5 bandgap voltage reference. If a larger output voltage is required, then an external amplifier has to be added.

The MAX038 contains its own low impedance output buffer, but this is of no use if the final output level needs to be varied, in this case by VR2. The wiper of VR2 is fed to the final stage formed by buffer chip IC3, an EL2001 manufactured by Elantec. The EL2001 is a 70MHz fixed unity gain buffer capable of driving 50Ω coaxial lines. R9 provides close to a standard 50Ω output impedance.

The power supply circuit comprising REG1 and REG2 is a standard +/-5V regulated supply fed by a half wave rectified AC input.

Construction

As can be seen from the photos, the unit is housed in a standard UB1 jiffy box measuring 90 x 150 x 50mm. This allows just enough room for both the main PCB and a small 7V AC mains transformer with an IEC mains input connector and fuse.

All of the circuitry for the unit is contained on a single sided PCB measuring 115 x 40mm, which is attached via the control pots to the front panel. The only internal wiring is to and from the mains transformer and the BNC output connectors.

All of the pots and switches are mounted at right angles along one side of the PCB. This not only makes assembly easier, but also reduces noise from internal wiring and provides a support for the PCB.

Start assembly with the low profile components such as the resistors and two diodes, followed by the bypass capacitors and ICs, and then the rest of the components.

With IC1 being more expensive than most of the other components combined, some constructors may wish to mount it in a socket. However for best performance it is recommended that it be soldered directly onto the PCB. If you must use a socket, then ensure that it is a low profile machined-pin type for minimum contact resistance and lead inductance.

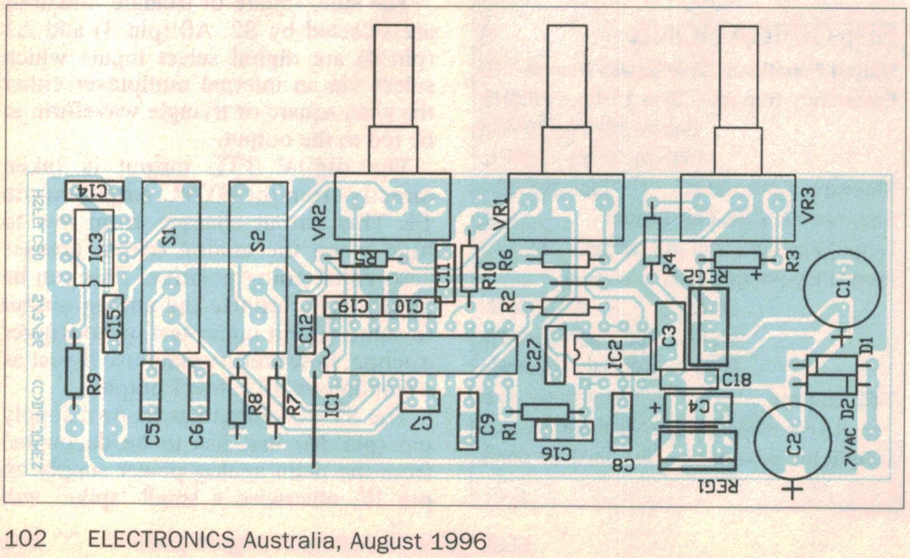
Using a 7V AC transformer for the supply, the regulators will only become warm and should not require a heatsink for normal operation. However, if a higher voltage AC supply is used, the regulators will most probably require a heatsink for any sort of continuous operation. If you do add a heatsink, be sure not to short the tags of both regulators together, as one is the supply input and the other is ground!

The next step is to drill the required holes in the front panel. Use a photocopy of the drilling template provided. Make sure that the centre hole for the pots is about 30mm in from one side of the front panel. (If the PCB is mounted too close to the middle of the box then there will be no room to mount the transformer.) There are no front panel mounting nuts used on the switches, so make sure these holes are clean and aligned properly. Now apply the front panel label, ensuring that it is aligned with the controls.

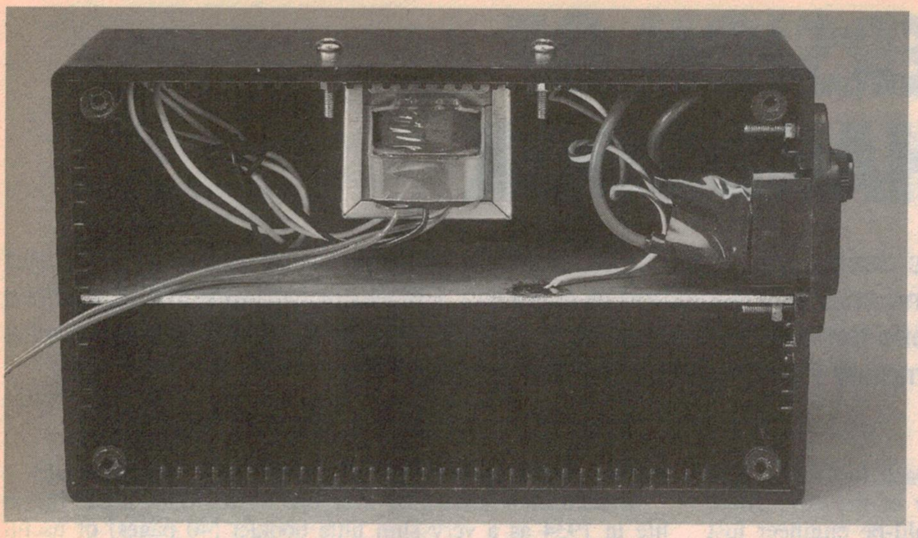
At this stage you can turn your attention to the holes required for the IEC mains connector, fuse holder, and transformer. The alignment of these holes is not critical, however it is recommended to mount the components as shown in the inside shot of the unit.

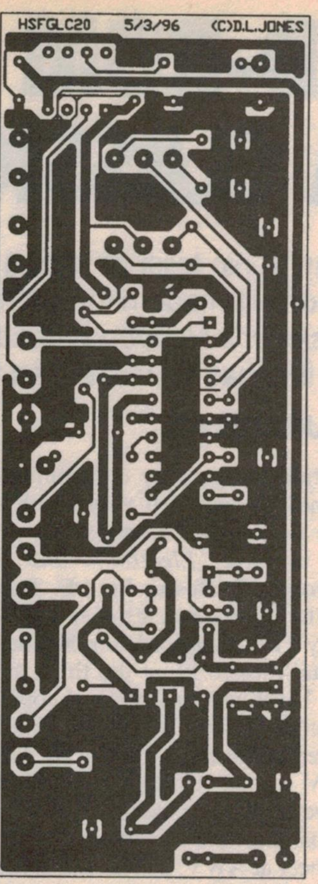
The mains wiring and transformer should be kept as far away from the PCB as possible, to minimise hum and risk of shorting. You can add a blank piece of earthed PCB as shown between the transformer and PCB to divide the box into two halves, one for the PCB and the other for the transformer and mains wiring. If you do this, be sure to connect the blank PCB copper to the mains earth.

When wiring the fuse holder to the active pin of the IEC connector, make sure it is connected to the END tag of the fuse holder and not the side tag. This is to ensure that the fuse holder does not become live when the fuse is replaced. Be sure to insulate all mains wiring, and make a solid mains earth connection to



Use this overlay diagram as a guide to wiring up the generator board. It's supported behind the front panel by the control pots and toggle switches.





Here is the etching pattern for the generator PCB, printed actual size for those who make their own.

the transformer frame. Ideally the transformer should be firmly bolted to a small earthed metal plate, and then the plate bolted into the plastic case — so that even if it should overheat and reach a high temperature, its earth connection will still be intact for your safety.

The transformer used in the prototype is a Dick Smith type M-2824, which has a centre-tapped 7V winding with an extra 7.5V winding. Only the ends of the 7V winding are used, so the centre-tap and extra windings can be cut off. Alternatively, insulate the ends and tie them up neatly within the case.

Before connecting the power, double check all of the mains wiring and measure the resistance of the transformer primary at the IEC input pins. You should get a value of around 2KΩ.

Before installing IC1 on the board, or in its socket, apply power and make sure that you get +5V and -5V on pins 17 and 20 respectively. Then if all is well, remove the power and fit the IC.

Once you have finished construction and the power on checks, the unit should be ready for use.

In operation

As there are no alignment or adjustment operations to perform prior to operation, the unit should work 'first go' as described.

Connect the main output to an oscilloscope and apply power. With the level control set to maximum, you should be able to get a waveform of the type selected by S2. Ensure that the three types of waveform are selectable, and that the MAIN and FINE frequency adjustment controls work on all three ranges selectable by S1. The three frequency ranges should overlap each other; if there is a gap between any of the ranges, C2, C3, or C4 might not have the correct value or tolerance. However this would be unlikely.

The three frequency range limits on the front panel are to be used as a guide only, as the actual range values are determined by the tolerance of the oscillator components. So setting the range to the '500Hz-100kHz' position and turning the frequency controls fully in one direction will most probably NOT give the indicated value.

The front panel frequency adjustment controls do not include a calibrated scale, as the very wide frequency coverage of each range would make the scale almost meaningless. This unit therefore, should be used in conjunction with a frequency meter. A 'T'-piece BNC connector can be used to allow simultaneous use of a frequency meter and the circuit to be tested.

Using an oscilloscope, there should be little or no apparent distortion of the sine wave up to 20MHz. However, the square wave function begins to approach a sine wave at frequencies above about 10MHz. This is due to a bandwidth limitation of the MAX038's output buffer. The triangle wave also suffers from this bandwidth limitation, but to a much lesser degree, and is still usable approaching 20MHz.

Note that to get any sort of accurate picture of the output waveform at 20MHz and above will require the use of an oscilloscope with a bandwidth of at least 100MHz.

Two prototype units reached a frequency of around 25MHz, with the sine wave still being reasonably clean. The final upper frequency all depends on the actual value of C7. C7 may be able to be tweaked to reach an upper frequency of over 30MHz. Higher frequencies and lower distortion are possible, but require the use of a properly laid out double-sided PCB — which is not warranted in a low cost design such as this.

That's all there is to the new low cost 20MHz function generator. I'm sure you'll find it as invaluable as I have. Happy generating! ❖

PARTS LIST

Resistors

(All 1/4W 5% unless stated)

R1	3.3k
R2-4	1k
R5	330 ohms
R6	6.8 ohms
R7,8	10k
R9,10	47 ohms
VR1-3	PCB mount 1k linear trimpot (small)

Capacitors

(All caps are 0.2" pitch unless stated)

C1,2	680uF 16VW RB electrolytic
C3,4	10uF 10VW tantalum
C5	1uF 10VW tantalum
C6	10nF monolithic
C7	22pF ceramic (0.1" pitch)
C8-18	0.1uF monolithic

Semiconductors

IC1	MAX038 (RS Components)
IC2	TL072 or similar
IC3	EL2001 (RS Components)
REG1	7905 regulator (TO-220)
REG2	7805 regulator (TO-220)
D1,2	1N4001

Miscellaneous

2 x SPDT switches, centre off, 90 degree PCB mount; Single sided PCB, 115 x 41mm, coded HSFGLC20; plastic utility box 160 x 96 x 55mm (UB1); 3 x fluted knobs; 7V/250mA AC mains transformer (Dick Smith Electronics M-2824); IEC panel mount mains plug; 240V AC panel mount fuse holder; 500mA fuse cartridge; 150 x 40mm piece of PCB laminate for shield; 20cm of 50 ohm coax cable; 2 x panel mount BNC sockets; front panel label.

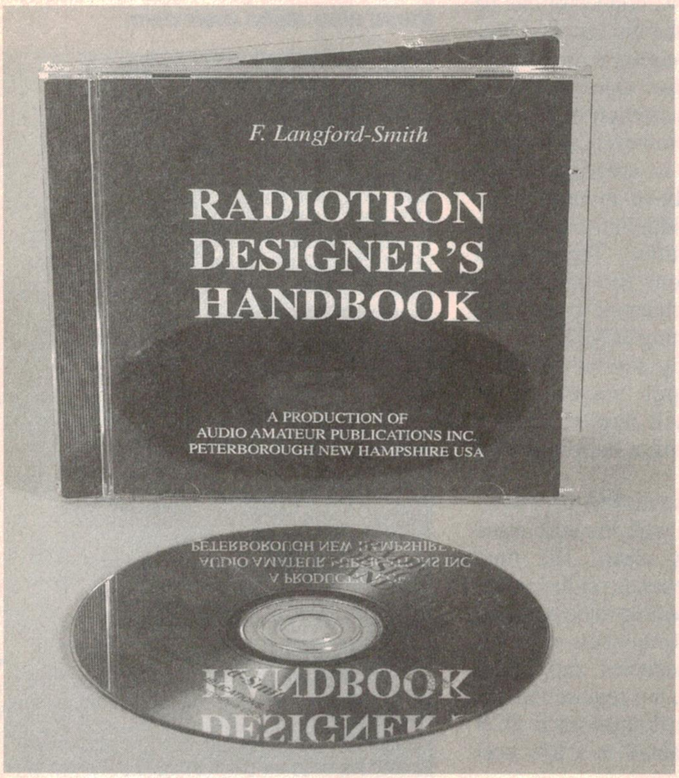
CD-ROM VERSION OF A CLASSIC HANDBOOK

In an ironic twist of fate, a classic design reference book of the thermionic valve era has just been 'reborn' in modern form. Written and originally published in Australia, Fritz Langford-Smith's *Radiotron Designer's Handbook* became world famous in its final Fourth Edition — last reprinted in 1963. But a US firm has now released the complete Fourth Edition, on a single CD-ROM...

by JIM ROWE

When I began my electronics course back in 1958, valve technology was still very much the order of the day. There were two main textbooks that every would-be engineer just *had* to have: *Electronic and Radio Engineering*, Fourth Edition by Professor Fred E. Terman of Stanford University, and the *Radiotron Designer's Handbook*, Fourth Edition, edited by Fritz Langford-Smith. They were both equally famous around the world, at the time, and became engineering classics. I still have my original copies of both.

Langford-Smith's book was much larger, and was of course written in Australia, largely by Australians. It was published by AWV — the Amalgamated Wireless Valve Company, or the 'valve company' side of AWA (then Australia's largest electronics manufacturer). Langford-Smith was senior valve applications engineer at AWV, and he and his colleagues (who included *EA*'s former Editor in Chief and current contributor Neville Williams, by the way) did most of the work in the AWV and AWA labs.



Somewhat more compact than the original: the CD-ROM provides all 1498 pages of the Fourth Edition, with hypertext linking to enable convenient accessing via Adobe Acrobat Reader.

Affectionately known by everyone as the *RDH*, it had begun life in 1934 as a very slim little booklet (40 pages) of useful design data and tables, to guide engineers and others in the design of radio receivers and audio amplifiers. But such was the response it received that AWV and Langford-Smith were soon encouraged to produce a Second Edition (1935), and then a somewhat more substantial Third Edition in 1940. This ran to 352 pages, and provided a great deal more in the way of explanatory text, design formulas, characteristic performance plots and so on.

The Third Edition was so successful that during the war AWV had to reprint it nine times, to produce a total of about 52,000 copies sold by the end of 1944. Just about every Australian engineer and technician of the day must have bought one, along with quite a few radio amateurs and experimenters...

The success of the Third Edition also attracted interest from overseas firms, like RCA in the USA and Wireless Press in the UK (publishers of *Wireless World*). As a result it was reprinted a number of times in those countries as well. In fact by about 1950, a total of over 280,000 copies had apparently been sold around the world...

Although already quite dated, because of the rapid developments in electronics during the war, the handbook had clearly become required reading throughout the industry. As a result, AWV encouraged Langford-Smith and his fellow engineers to update and expand it still further. This took a great deal of effort, spanning a few years, but the result finally appeared in 1952 as the famous Fourth Edition: no less than 1474 pages of solid technical information.

Despite its massive size, it had been deliberately limited in scope. In his Preface, Langford-Smith explained that the Fourth Edition had been written *as a comprehensive, self-explanatory reference handbook, for the benefit of all who have an interest in the design and application of radio receivers or audio amplifiers. Everything outside this field — television, radio transmission, radar, industrial electronics, test equipment and so on — has been excluded to limit the book to a reasonable size.* The mind boggles to think how big it might have been, if this exclusion had not been done!

Not surprisingly, the Fourth Edition was also reprinted a number of times, both here and overseas, and undoubtedly became a classic textbook of the valve era. It was revised and expanded with the fourth impression in 1955, to 1498 pages, and the last Australian printing seems to have been in 1963.

Of course transistors soon came in, and then ICs, and the valve era quietly came to a close. Not only that, but the design of radio receivers and audio amplifiers tended to fade in Australia anyway, when local firms opted out of manufacturing domestic electronics items. Gradually books like the *RDH* lost their appeal, even though a lot of the basic design information it contained applied

just as much to solid state equipment.

Renewed interest

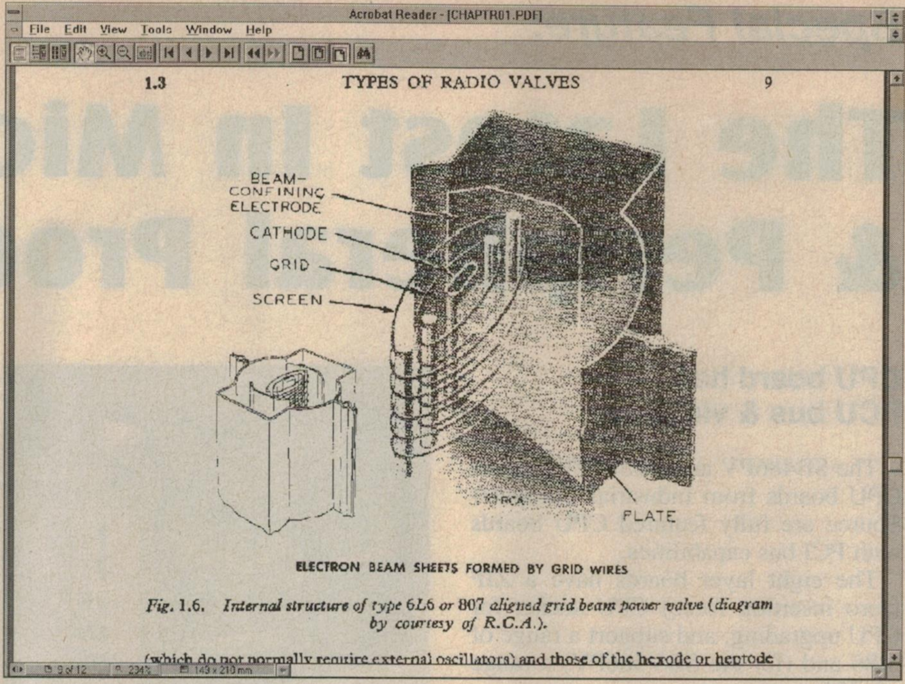
But in recent years there's been a renewed interest in valve technology around the world — due to both the growth of vintage radio as a hobby, and the continuing use of valves in equipment like guitar amplifiers and 'high end' domestic hifi systems.

As a result of this renewed interest in valves, reference books like the old *RDH* have become eagerly sought out again, not only by vintage radio enthusiasts but also by a new generation of audio equipment designers. Copies are snapped up as soon as they come to light, and like many 'collector's items' their second-hand value is steadily rising again...

It's presumably because of this renewed interest in the *RDH* that US firm Audio Amateur Publications Inc., of Peterborough, New Hampshire, has recently gone to the trouble of republishing the entire Fourth Edition, in modern CD-ROM form.

This has involved some poor soul scanning in all 1498 pages of the revised version, as reprinted by RCA in 1955, and then saving the image files for all of these pages on a CD. What a job!

It's more than just an enormous collection of page images, though. As part of the deal they've used Adobe Acrobat to collect and annotate all of the page files into groups according to the original chapters, and also added hypertext links from the initial chapter listing to the main contents listing, and then from the contents listing to each individual chapter.



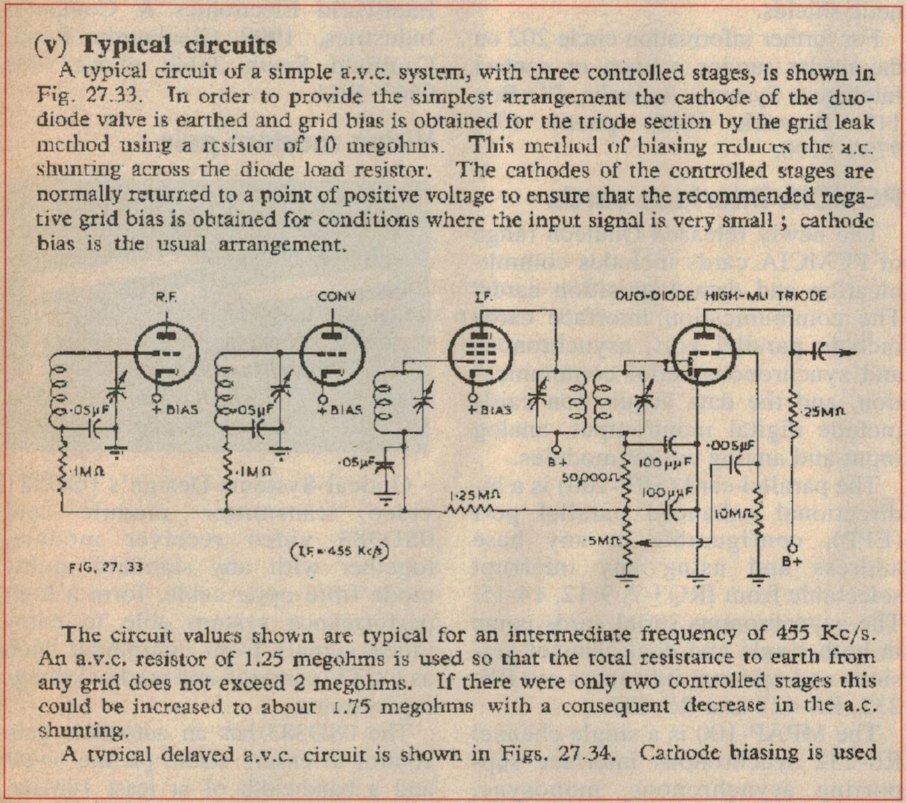
A screen dump showing the type of display produced by Acrobat Reader when you're looking at a page of the Radiotron Designer's Handbook, viewed at the largest of the three magnification options.

Adobe Acrobat Reader is supplied on the CD-ROM along with all of the *RDH* files, and is easily installed on your hard disk (it requires a 386 or higher IBM compatible, Windows 3.X and about 1.13MB of disk space). You use it to actually read the book, taking advantage of the hypertext linking. All of which makes it rather easier to use as a reference — still not quite as easy as the original book, mind you, but not difficult once you get the hang of it.

Of course once Adobe Acrobat Reader is installed on your system, you'd also be able to use it to read any other compatible files. As well as being able to view the pages on the monitor screen, it also allows you to print out any desired page or sequence of pages — on your usual Windows printer.

In short, it's an interesting and quite practical approach to republishing a classic textbook, in modern electronic form. So if you've never been able to pick up a copy of the Fourth Edition of *RDH*, and would like one, it would be well worth considering.

In Australia the Radiotron Designer's Handbook CD-ROM is available for \$109.50 from ME Technologies, of PO Box 50, Dyers Crossing 2429; phone (065) 50 2200 or fax (065) 50 2341. You can also e-mail them on the Internet at **me@midcoast.com.au**, or visit their Web site at **http://www.midcoast.com.au/bus/me.** ❖



(v) Typical circuits

A typical circuit of a simple a.v.c. system, with three controlled stages, is shown in Fig. 27.33. In order to provide the simplest arrangement the cathode of the duo-diode valve is earthed and grid bias is obtained for the triode section by the grid leak method using a resistor of 10 megohms. This method of biasing reduces the a.c. shunting across the diode load resistor. The cathodes of the controlled stages are normally returned to a point of positive voltage to ensure that the recommended negative grid bias is obtained for conditions where the input signal is very small; cathode bias is the usual arrangement.

The circuit values shown are typical for an intermediate frequency of 455 Kc/s. An a.v.c. resistor of 1.25 megohms is used so that the total resistance to earth from any grid does not exceed 2 megohms. If there were only two controlled stages this could be increased to about 1.75 megohms with a consequent decrease in the a.c. shunting.

A typical delayed a.v.c. circuit is shown in Figs. 27.34. Cathode biasing is used

Acrobat Reader also allows you to print out any page, or any range of pages in the chapter currently being viewed. This portion of a page shows the kind of reproduction possible.

Special Feature:

The Latest In Micros & Peripheral Products

CPU board has PCU bus & video

The SB486PV and SB586PV plug-in CPU boards from Industrial Computer Source are fully featured CPU boards with PCI bus capabilities.

The eight layer boards have a ZIF (zero insertion force) CPU socket for CPU upgrading, and support a range of '486 and (for the SBV586PV) a range of '586 processors.

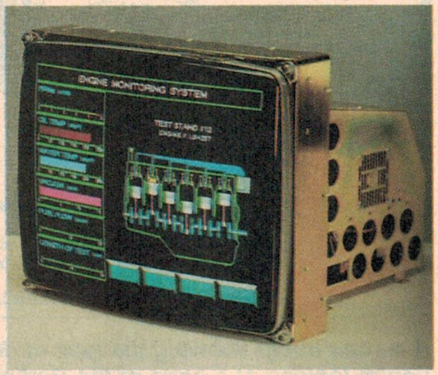
The boards come with on-board PCI bus IDE, and a video controller with 1MB RAM which supports up to 1024 x 768 x 256 colour non-interlaced video. A floppy drive controller and two high speed 16550 UART compatible serial ports and a Centronics compatible port are also included. The board supports up to 256KB cache memory and can accept up to 64MB DRAM (72 pin SIMMs). The mean time between failure rating is better than 77,000 hours, and the boards have an operating temperature range of 0-60°C.

For further information circle 201 on the reader service coupon or contact Interworld Electronics & Computer Industries, 1000 Glenhuntly Road, Caulfield South 3162; phone (03) 9563 5011.

20" and 21" industrial monitors

Intecolor Corporation has released a range of variable scan industrial monitors. The monitors scan from 30kHz to 80kHz with resolutions ranging from 640 x 480 to 1600 x 1280. They have a 0.28mm dot pitch CRT with anti-static protection and a low ELF/VLF emissions yoke. Features include high bandwidth differential video inputs for noise immune operation and remote display capability, dynamic focus and a high contrast INVAR shadow mask CRT.

The MIL 217 design specification allows the monitors to work in harsh environments. They have a vibration tolerance of 1.59g (operating) and a rated



MTBF of over 60,000 hours at 25°C.

The monitors are available in many enclosure designs such as rackmount, panelmount, desktop, benchtop and open frame models, and with options that include auto-tracking, power factor correction, touch screens and magnetic shields.

For further information circle 202 on the reader service coupon or contact Intelligent Systems Australia, PO Box 118 Berwick 3806; phone (03) 9796 2290.

PCMCIA interface cards

The newly released Quatech range of PCMCIA cards includes communication and data acquisition cards. The communication interface cards include parallel port, asynchronous and synchronous serial communication, and the data acquisition cards include digital input/output, analog input and analog output modules.

The parallel card (SPP-100) is a bi-directional enhanced parallel port (EPP), configurable at any base address and using any interrupt selectable from IRQ3-7, 9-12, 14-15. The asynchronous serial cards come in both single and dual channel versions and optional interfaces are RS-232, RS-422 and RS-485.

The MPAP-100 is a single channel RS-232 synchronous interface supporting asynchronous, monosync, Bisync, HDLC and SDLC protocols. It uses the Zilog 85320 serial communication controller chip and comes with Syncdrive, a frame level HDLC and Bisync software driver.

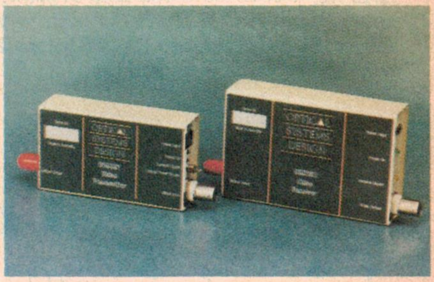
The IOP-241 is a buffered 24 line I/O module; each line can be configured as input or output. Eight lines can be used as interrupt sources (level sensitive or pulse triggered).

The DA8P-12 is an eight channel 12-bit resolution analog output card with eight digital I/O lines, available in unipolar or bipolar versions. The DAQP-12 and DAQP-16 are 12-bit and 16-bit analog input cards. Both cards have a 512 sample FIFO to ensure full speed data acquisition under various operating platforms, including DOS and Windows.

All cards are Type II, and come with PCMCIA card services.

For further information circle 204 on the reader service coupon or contact Interworld Electronics & Computer Industries, 1000 Glenhuntly Road, Caulfield South 3162; phone (03) 9563 5011.

Video modem pair



Optical Systems Design's 0SD381 video transmitter module and 0SD383 video receiver module, together with any standard multi-mode fibre optic cable, form a high performance system able to carry video signals from equipment such as CCTV cameras and medical imaging systems.

The 0SD383 has an automatic gain control to ensure stable picture levels and a bandwidth of at least 10MHz, making it suitable for CCTV surveillance and many medical applications such as CAT scanners.

Both modules include signal indicators to greatly simplify system fault finding. They are supplied in small sturdy steel enclosures and can be powered by almost any 12V (nominal) AC or DC power source.

For further information circle 203 on the reader service coupon or contact Optical Systems Design, PO Box 891, Mona Vale 2103; phone (02) 9913 8540.

Multifunction PC-based instrument

The TiePie Engineering model TP508 is a plug-in computer card that operates as a digital storage oscilloscope, true RMS voltmeter, spectrum analyser and transient recorder. The half size card plugs into a free slot in any IBM compatible computer.

As a DSO, the card provides two 8-bit channel inputs with a bandwidth of 20MHz and a sample rate of 50MS/s. With a 10:1 probe, input signals up to 600 volts can be measured. The true RMS function allows measurements (up to 5MHz) of effective value, peak to peak, mean value and min/max modes, along with dBm, power and frequency. In addition, a signal generator is built in, which produces a square wave output from 100Hz to 100kHz with an amplitude of +/-2V.

The spectrum analyser measures over the range of 1Hz to 24MHz with an accuracy of 0.2% using FFT calculation techniques. It can display harmonic distortion, maximum or mean values. The transient recorder can record a variety of signal events with a measurement time of from 0.01 sec to 300 sec, with one to 30,000 measuring points.

All measurements and functions are controlled by software provided with the card. The software allows instrument and function setups to be saved for later use, measurements to be saved to disk, viewed in real time or printed. It also saves data in a form that can be read by all spreadsheet programs.

For further information circle 205 on the reader service coupon or contact Emona Instruments, PO Box 15 Camperdown 2050; phone (02) 519 3933.

ISA/PCI Pentium VGA computer card

The PSC-586VGA is a single board computer that supports a range of CPUs at clock speeds up to 166MHz, including the Intel Pentium, IBM/Cyrix 6X86, and the AMD K5. It also supports up to 1 MB of burst, pipeline burst (synchronous and asynchronous), and standard cache RAM.

The card has four 72-pin SIMM RAM slots and supports up to 128MB of EDO DRAM or standard DRAM, and up to four PCI master peripheral cards at a PCI clock speed of 33MHz. It has two 16550 compatible high speed serial ports, one bi-directional parallel port, two EIDE interface ports (four IDE drives), and supports two floppy disk drives.

There's a Cirrus Logic GD54M30 32-bit PCI SVGA controller, with a 32-bit BitBLT graphics engine and 512KB or 1MB of video memory. It has an integral PS/2 mouse port (saving a serial port), a keyboard connector, a battery-backed real time clock chip that ensures accurate time keeping for up to 10 years, and an adjustable watchdog timer that generates a reset if the system stops operating correctly.

The card is rated for operation over the temperature range of 0 to 60°C, and 0 to 95% relative humidity (non condensing).

For further information circle 206 on the reader service coupon or contact Click Electronics, 174 Parramatta Road Auburn 2144; phone (02) 647 2322. ❖

Silicon Valley NEWSLETTER

Texas chief dies on European trip

Jerry Junkins, chairman of Texas Instruments, died of a heart attack during a business trip to Germany on Wednesday May 29. Junkins, 58, was rushed to a hospital in Stuttgart, where he died. Junkins was revered throughout the high-tech industry, and credited for TI's strong comeback in the 1990s as a world leader in memory and other semiconductor technology.

TI vice chairmen Bill Mitchell and Pat Weber, who with Junkins comprised its office of the chief executive, announced they would oversee day-to-day operations until a successor to Junkins was chosen. It was expected that TI's board of directors would chose one of the two men and would do so quickly, to ensure continuity of leadership at a time of uncertainties in the chip market, from which TI derives about US$9 billion of its $13 billion in annual revenues.

"We are deeply saddened by Jerry's death. With his courage and vision, he led TI into a new era of opportunity and growth", stated Mitchell. "He valued the contributions of every TIer and encouraged creativity and innovation. Jerry embodied and promoted the strong ethical and business principles upon which TI was founded."

A native of tiny Montrose, Iowa, and the son of an auto mechanic, Junkins joined Texas Instruments as a manufacturing engineer in 1959. Through the 1960s and seventies, he built his career in the company's defence products division. In the early 1980s, he assumed broader management responsibilities, with several additional TI businesses reporting to him, including data systems, industrial systems, consumer products, and the company's worldwide information systems network. He was named TI president and chief executive officer in 1985, and chairman in 1988.

In addition to his TI duties, Mr Junkins participated in a range of activities in business, government, civic affairs, and education. He was a director of Caterpillar, The Procter & Gamble Company and 3M, and was also on the board of the US-Japan Business Council.

Junkins was known for his casual, no-nonsense style. Instead of a driving a sports car or being chauffeured to work in a limousine, he drove an old Cadillac with a trailer hitch. He relaxed by chopping wood, riding a tractor or doing home repairs.

TI announces leap in chip technology

In a sad irony, on the same day that Texas Instruments lost its long-time chairman and CEO the company announced what may well become its crowning achievement: a chip manufacturing technology that will allow it to cram up to 125 million transistors onto a single chip. That is 20 times the density found on Intel's 6-million transistor Pentium processor...

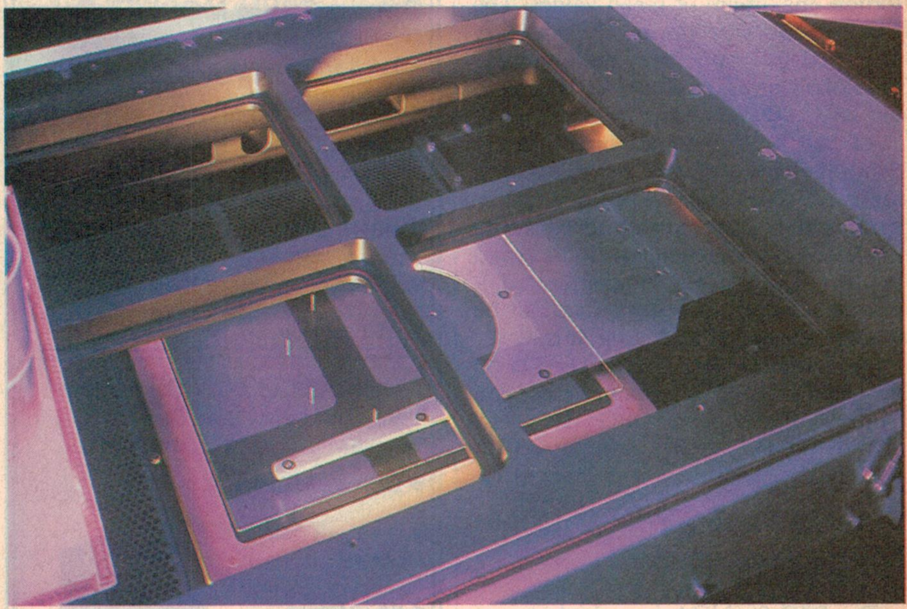
The new TI chip manufacturing technology uses 0.18um design rules, equivalent to laying 550 IC circuits on an area the width of a human hair.

TI said it has already lined up one customer with an IC design application for a high-level engineering workstation to take advantage of this technology. Analysts said it is likely workstation leader Sun Microsystems is the intended customer, as TI is the major supplier of Sun's Sparc line of microprocessors.

If successfully implemented the 0.18um production capability would enable TI to leapfrog many of its competitors in the semiconductor industry, most of whom are just now gearing up for the 0.35um production that will produce 64Mb DRAM memory chips. At 0.25um, a production technology slated for the 1998-1999 time frame, 256Mb DRAMs will become mass produceable, while at 0.18um, one-gigabit DRAMs will become feasible.

Besides TI, IBM and LSI Logic have announced intentions to start producing with 0.18 micron design rules. TI said it hopes to sell the technology to other chip makers when it is ready — sometime next year.

A move toward 0.18um capability two to four years ahead of what had been anticipated would open the door to a vast range of new business and consumer product, ranging from single-chip PCs with the performance capability of today's most powerful workstations to picture phones, computers that recog-



At the recent SID '96 display technology trade show in San Diego, chip equipment maker Lam Research announced this new 'Continuum' dry plasma etching system for making flat-panel displays. It can process displays measuring up to 600 x 720mm, and was developed with US$13.6 million in funds supplied by the US Display Consortium (formed to give support to US display makers).

nise human speech patterns, or automated teller machines that recognise a bank customer's face or fingerprint.

Consumer-level applications of the new TI chip technology will start to show up in retail stores around the turn of the century, industry analysts said.

Virginia snaps up 64Mb DRAM project

The state of Virginia, never a big name in the semiconductor industry until IBM announced last year it would build a 64-megabit DRAM facility in the state, has snatched up a second such fab. Motorola and Siemens, two of IBM's four partners in a joint advanced DRAM development consortium, said they will build their joint fab near Richmond, Virginia.

The facility will initially target 0.35um production for 64Mb chips on 8" wafers, but will be designed to move on to production of 0.25um 'shrink 64Mb' and 256Mb chips in subsequent stages.

The plant will have a total cost of US$1.5 billion and is expected to come online in mid-1998. Between 1000 and 1500 people will be employed there.

Besides the new Richmond fab and IBM's DRAM facility in Old Dominion, Motorola is also building a major new logic chip fab near Richmond. However completion of that facility has been put off for a year as part of a general cutback in 1996 spending.

IBM & Hughes in silicon-germanium project

Gallium arsenide, which dazzled chip and computer designers in the early 1980s with its potential of blistering speeds, never developed into a serious threat to silicon due in large part to the brittleness of the material — making volume production impossible. However IBM and Hughes Electronics hope another material, silicon-germanium will now take over where GaAs failed. The two firms plan to jointly develop Si-Ge technology for commercial use, and hope the first devices will be ready for production in 1997.

The program will use a Si-Ge manufacturing process currently under development at IBM's Advanced Semiconductor Technology Center in East Fishkill, New York. Research on the Si-Ge semiconductors, which offer two to four times the switching speed of silicon at substantially less power, has been under way since 1982.

Key to the success of the new material will be the ability to grow the Si-Ge crystals into ingots that can be sliced into wafers.

IBM researchers said their work has shown that Si-Ge wafers can be processed on existing silicon fab lines. Hughes intends to use the technology in high-speed wireless and sensing devices such as automotive radar, interactive TV, and wireless networks. Company officials say the new material will set a new price-performance standard.

Navigation via both US & Soviet satellites...

Several high-tech companies have announced the first global positioning system (GPS) products based on a unique combination of signals from both US and former Soviet Union navigation satellites. The combination will allow for simpler and more accurate tracking of everything from rental cars, delivery trucks, and even prisoners and people under house arrest.

Ashtech of Sunnyvale launched a GPS receiver that will be able to decipher signals from both the US Global Positioning System (GPS) network and the Russian Global Navigation Satellite System (Glonass). 3S Navigation, a company in Laguna Hills in Southern California, also launched the third generation of its GPS-Glonass receivers. Right now, the two products are expensive. Ashtech's begins at US$5995 while the 3S system sells for $14,500.

Ashtech, a nine-year-old private company with US$35 million in sales last year, hopes to sell its receivers to many different industries. It developed the receiver with help from 85 Russian scientists, whom it hired for relatively low wages. The Russians devised the complicated maths algorithms, or formulas for deciphering Glonass signals, while Ashtech developed the GPS technology as well as the custom semiconductor chip used to process the signals.

The combined GPS/Glonass network will make 48 satellites available for navigation purposes, making up for the scarcity of satellites when only one system is used. The US GPS system consists of 24 satellites that orbit 12,000 miles above the Earth. It takes as many as five satellite signals to confirm someone's location in terms of longitude, latitude, altitude and time. The measurements are usually only accurate to within 100m, because the US Air Force scrambles the GPS signal so that military adversaries can't use it.

With Glonass and GPS wired into a single system, up to 16 satellites are overhead at any given time, resulting in increased accuracy to within 15m as the Russians do not scramble their signals.

GPS industry leader Trimble Navigation in Sunnyvale, said it does not plan to add the Glonass signals to its product line, saying the Russian satellite network has been unreliable, with satellites malfunctioning or falling out of orbit far more frequently than the GPS satellites.

The GPS market is expected to quadruple to an US$8 billion industry by 2000.

US$50M for Sematech 193nm litho program

The US-based Sematech semiconductor research consortium announced that the US government has committed to the full US$50 million the consortium had asked for in the final year it will accept public funds. The money means Sematech will be able to move ahead with a program to develop 193nm (0.19um) optical lithography technology.

"We will go ahead and launch our lithography programs in 193nm and other infrastructure development", said a Sematech spokesman. "If we hadn't gotten the money, we would have looked at other ways of funding it, or just not done as much." He said efforts would focus on development of light sources, lenses, and exposure platforms for 193nm.

Meanwhile, the Sematech board has developed a short list of candidates to succeed chief executive William Spencer, who may be asked to stay on for a short time past his planned end-of-year departure to overlap with the new CEO.

Kodak reveals low cost digital camera

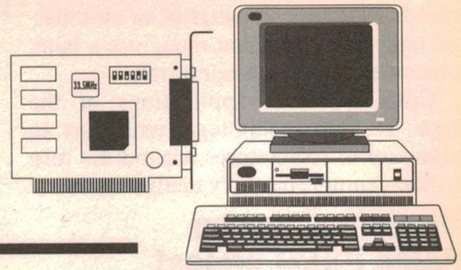
Eastman Kodak has unveiled a compact US$350 digital camera that is small enough to fit into a shirt pocket — and is aimed at home PC users.

The Kodak Digital Science DC20 stores between 8 and 16 colour pictures, depending on the resolution selected, and transfers them to a Macintosh or Windows-based computer. The product comes with software which allows users to insert photos into greeting cards, distort photos in fun ways, create slide shows or send e-mail 'postcards'.

Meanwhile, Sony announced plans to launch a headset-based high resolution LCD monitor that will allow individual viewing of movies and video discs. The PLM-50 Glasstron plays back images from a videocassette recorder or a video compact disc player. Built-in stereo earphones relay the sound.

Used in conjunction with a battery pack and lightweight CD player, the new product, like the Sony Walkman, is a portable, individual entertainment system. It measures 7.9 x 4.7 x 10.2 inches, weighs 11 ounces and will be priced at around US$800. ❖

Computer News and New Products



Anti-virus software

VET version 9.0, claimed as the most up-to-date Australian anti-virus software, is currently being shipped to all registered users. It will detect many thousands of viruses, including seven new 'macro viruses'.

The software includes virus protection for Windows 95, Windows 3.1 and DOS users and is fully compatible with OS/2 and all popular networks. Version 9.0 includes upgraded security features, efficiency enhancements and protection against hundreds of new viruses. It also offers automatic Internet and e-mail virus protection for Windows 95 users, Word 6/7 macro virus protection and background virus monitoring. Versions for Windows 95, Windows 3.1 and DOS are in the one pack, and the RRP is $126 — which includes free quarterly upgrades for one year and free unlimited technical support.

For further information circle 160 on the reader service coupon or contact Cybec, 350 Hampton Street, Hampton 3188; phone (03) 9521 0655, e-mail **info@cybec.com.au**

8x CD-ROM drive

Plug and Play compliant, the new TEAC CD-58E 8x speed CD-ROM drive is an internal device, in a standard 5.25 inch half height format. It can be mounted horizontally or vertically. The motorised tray loading eliminates the need for a caddy. The rated mean time before failure (MTBF) is 100,000 hours.

Performance figures include an average access time of 125ms and a 1.2MB/s data transfer rate. The drive also supports DMA data transfer requiring less than 10% CPU utilisation, making it suitable for multi-tasking applications.

The player has an ATAPI (IDE) interface and is compatible with the CD-DA, CD-ROM XA mode-2 (form-1, form-2), multi-session Photo CD, CD-I, Video CD, CD Plus and enhanced CD formats.

For further information circle 161 on the reader service coupon or contact Southend Data Storage, PO Box 25, Bangor 2234; phone (02) 749 2633.

Tiny Flash disk

DSP Design has released Tiny Flash disk (TFD), which is a range of embedded solid state Flash disks and drivers which provide a high speed and reliable disk medium for embedded systems. All TFD products are PC/104 modules, with the smaller capacity modules having a smaller form factor to save space.

TFD provides up to 40MB of non-volatile solid state disk per module, and up to four units can be used in any system. It comes with True Flash File System (True FFS) software for solid state disks, which manages the special requirements of the Flash hardware (including wear levelling). The software is provided as a BIOS extension ROM on the TFD board, and is automatically installed during the system boot process. Files are written and read using the normal DOS functions. The TFD module is specified for a minimum of 100,000 erase cycles.

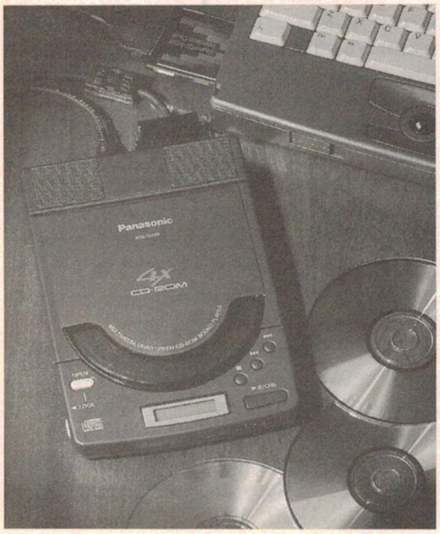
In many configurations you can load your operating system from TFD. The data read rate can be up to 100 times faster than a mechanical disk, giving very fast boot and program load time.

For further information circle 162 on the reader service card or contact DGE Systems, 103 Broadmeadow Road, Broadmeadow 2292; phone (049) 61 3311.

Datacom insert

Included in the subscription copies of this issue is a complementary copy of *Datacom Spotlight*, a short-form catalog produced jointly by Patton Electronics and CommsWare Australia. The catalog is packed with the latest in network access products from one of the world's leading manufacturers of reliable, effective short range modems, interface converters, G703 modems and surge protectors. Designed and manufactured to world-class standards, the Patton range of products are distributed exclsuively in Australia by CommsWare.

Contact CommsWare on 1 800 077 999 or fax 1 800 807 870 for further information, or to obtain your free copy of the new 140-page 1996 edition of the complete CommsWare catalog.



Quad portable CD-ROM players

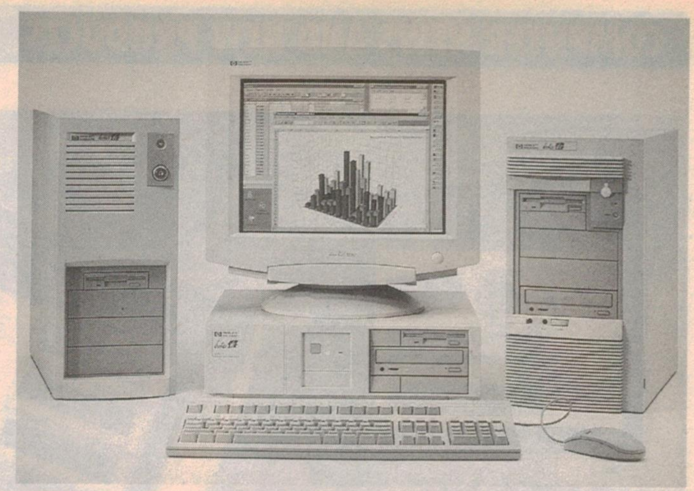
Panasonic's two new completely portable quad speed CD-ROM players can connect to a notebook or desktop computer. Called the KXL-D740 and KXL-D745, the players connect to a notebook computer through a standard PCMCIA Type II card, supplied with the players, or to a desktop computer via a SCSI-2 interface.

The features on the two models are the same except the KXL-D745 has built-in speakers and Sound Blaster compatible sound. They have a transfer rate of 600KB/second, a typical access time of 295ms and a memory buffer of 128KB. The units can be powered by an AC adaptor supplied with the unit, six AA batteries (not supplied) or an optional NiCad rechargeable battery pack. To help save battery power, the players have a power save feature which puts them into 'sleep mode' after four minutes of inactivity.

The units support many CD formats including CD-I, CD DA and Photo CD multi-session. Audio CDs can also be played with optional headphones or via the speakers on the KXL-D745.

Both units weigh 390 grams without batteries and measure 138 x 204 x 35mm (w x d x h). They are also Windows 95 compatible. Recommended retail prices are: $799 (KXL-D740) and $1099 (KXL-D745). For further information contact Panasonic's Customer Care Centre on 132 600.

HP cuts prices for its Vectra PCs



Hewlett-Packard has announced price cuts across its complete line of HP Vectra series PCs. The HP Vectra Pentium-based commercial PCs in Australia will begin at $2036 (estimated street price, including sales tax), with some models reduced in price by up to 22%. The Vectra Pentium Pro-based high performance PCs will now start at $8294 representing a price reduction on some models of up to 12%.

The HP Vectra VE series 2 PC, with a 75MHz Pentium processor, a 1280MB hard drive and 8MB of EDO RAM is now priced at $2156. The HP Vectra XM series 4 PC, with a 100MHz Pentium processor, a 1280MB hard drive, 16MB of EDO RAM, integrated Ethernet and remote DMI is priced at $3176. HP also provides its own three year next day on-site warranty.

For further information call HP on 131 347 or visit at **http://www.hp.com/go/vectra**.

PC diagnostics for Windows 95

PC Care, from American Megatrends, manufacturer of AMI BIOS and AMIDiag v4.5, is claimed to be the complete Windows 95 problem solver for technicians and end users. The software has five modules which work together to improve PC performance.

The System Info and Tune Up modules give information about hardware and software settings to determine how to improve performance. The Diagnostics module determines software and hardware problems and checks all system components including processors, memory, hard disk and multimedia. The Clean Up module removes unnecessary files from hard drives including temporary, redundant, orphan and unneeded system files. The Uninstall module lets the user remove any application, font or driver, including all icons, program groups, system file entries, DLL and INI files.

The software also features intuitive screens to help users of any skill level. It uses Windows 95 features including graphical tree display of components, full drag and drop capabilities, right click menus and intelligent icons. It gives a graphical animation of diagnostics as they are performed, such as testing the CD ROM, CPU, memory, speaker system, fax/modem, ports and so on.

PC Care has an RRP of $89 and requires Windows 95 and a minimum of 8MB RAM.

For further information circle 163 on the reader service coupon or contact Tech Star International, PO Box 259, Paddington 4064; phone (07) 3367 1444.

4x read/write CD-ROM drive

TEAC has released the CD-R50S quad speed write/quad speed read CD-R drive, claimed to be the first CD-R drive to satisfy MPC level 3 CD-ROM specifications of x4 read speed and less than 250ms access speed. The SCSI interface transfers data at 8.5MB/s.

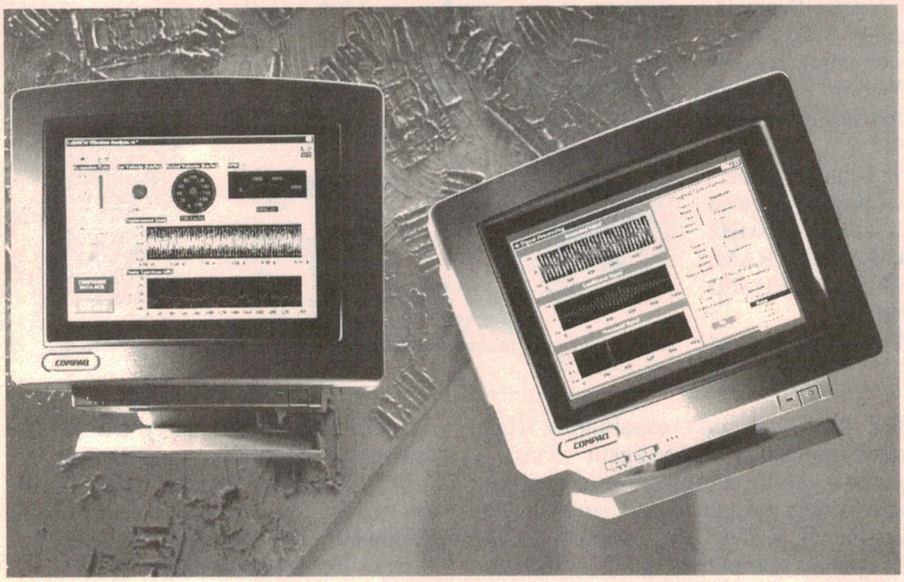
The unit is compatible with CD-DA, Video-CD and CD Plus recording formats. It is also compatible with CD-DA, CD-ROM (mode-1, mode-2,), CD-ROM XA mode-2 (form-1, form-2), multi-session Photo CD, CD-I, Video CD, CD Plus and Enhanced CD. It has a one megabyte internal write buffer.

For further information circle 164 on the reader service coupon or contact Southend Data Storage, PO Box 25, Bangor 2234; phone (02) 749 2633.

Diagnostic software for networks

The new release of the graphical network documentation tool, netViz 2.5 has been upgraded to more closely accommodate special Australian networking conditions. It comes with an automation kit to customise the software and an auto-discovery function which examines a network and stores in a text file, client and server information, such as connection name and network address. This file lets netViz automatically create and document a network diagram.

A feature of the software is its ability to define different link types as well as node types and record information unique to each network. Double click on any node to view its subsidiary network in a separate window or data relating to that node. Nodes in the subnetwork can also be expanded into sub-sub network windows and so on.



Select the project hierarchy window which shows the location of every node in the network, to get down to any level.

Another new feature provides concurrent file access and enables any node or symbol to execute an application program. This means users can link word processing documents such as historic PC maintenance information, with any node on the diagram. The optional netViz OLE2.0 Automation Kit allows users to invoke netViz application programming interface (API) calls from C, C++ or Visual Basic programs to manipulate displays and perform database functions. The software is priced from $1175.

For further information circle 165 on the reader service coupon or contact AustAsia Computer Engineering, No.1, 598 St Kilda Road, Melbourne 3004; phone (03) 9529 6633.

Virtual instrument software upgraded

National Instruments has announced major upgrades of the company's LabVIEW graphical programming software and LabWindows/CVI visual development software for virtual instrumentation. LabVIEW and Lab-Windows/CVI can now be used together to build virtual instruments, combining graphical and C programming within a single system.

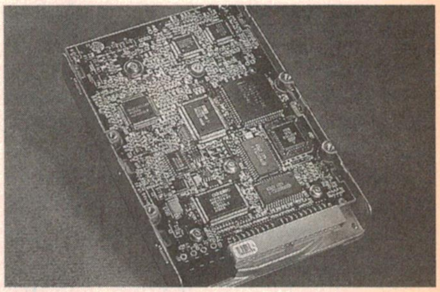
LabVIEW 4.0 features the new FlexVIEW customisable development environment, so users can create their own workspace to match their industry, experience and development skills. To integrate LabVIEW graphical programs with external software environments, Version 4.0 features OLE-based connectivity and distributed execution tools.

LabWindows/CVI 4.0 extends the complete collection of Lab-Windows/CVl user interface tools, instrument drivers, analysis routines and I/O libraries to users of standard C/C++ development tools from Microsoft, Borland, Symantec, and WATCOM. Additionally, LabWindows/CVl adds new visual development tools to streamline C code development. Both LabVIEW and LabWindows/CVI are now shipped with CodeLink, a new connectivity tool for integrating standard C code developed in LabWindows/CVI into the LabVIEW graphical programming environment. Both products feature native 32-bit versions for Windows 95 and Windows NT.

For further information circle 166 on the reader service coupon or contact National Instruments Australia, PO Box 466, Ringwood 3134; phone (03) 9879 9422.

2GB hard disk for desktop PCs

Maxtor Disk Drives has released a 2.0 gigabyte 3.5" enhanced IDE hard drive for the Australian desktop PC market. The new drive features enhanced reliability, low power consumption and power saving features to support energy efficiency standards.



A recent independent US survey found that the Maxtor 2.0GB disk drive was rated by value added resellers as the 'most reliable, and best overall disk drive on the North American market'.

Mr Nick Gaynor, Director of Maxtor Disk Drives, commented that "The new 2.0GB drive reflects several recent changes at Maxtor that will have a significant effect on the Australian market. Maxtor has been purchased by Hyundai Electronics, which has chnaged the engineering emphasis of the company to a pursuit of total quality."

The new disk drive is available through most leading retailers. For further information circle 167 on the reader service card or contact Maxtor Disk Drives, Suite 103, 55 Grafton Street, Bondi Junction 2022; phone (02) 369 3662 or fax (02) 369 2082. ❖

Save time and money with

Circuit Works Conductive Pen

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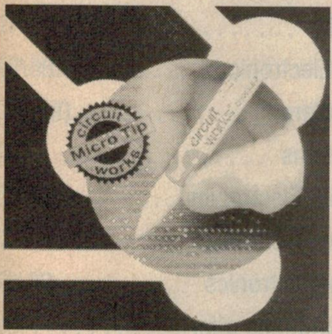

Every circuit engineer or technician needs this handy pen! The 2200 liquid conductor is a specially formulated silver bearing polymer which makes electrical connections. Dries in 3 to 5 minutes at room temperature. Heat curing improves conductivity and allows solderable terminations (do not exceed 350°F for more than 5 seconds).

Pen contains approx 30m of connections and has a spring loaded tip to prevent clogging and drying.

To use simply shake pen for 20 seconds to mix conductor, press tip on work surface. Finger pressure on pen barrel adjusts flow rate. It's that simple! Can be used on flexible and rigid surfaces – circuit film, key pads, glass, laminates etc. 50-60% silver assay with 10-15micron particle size. Resistivity 0.2-0.05Ω/sq @ 1mil.

Cut re-work and repair time and cost! Speed prototype development! Circuit Works 2200 Pen **$23.95**

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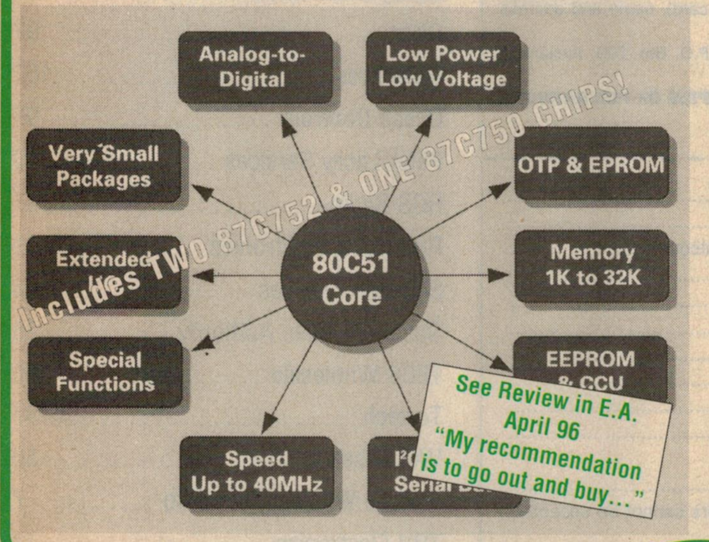
Well here's the low cost way to do it with the DS-750 Development Kit from Philips for only $159.90!!



- **Emulates 87C750 Microcontrollers in Real-Time**
- **Programmable Clock up to 40MHz**
- **Built-in Programmer for 87C750/1/2**
- **High-speed Hardware Simulator**
- **Source-Level Debugger for C, PLM and Assembler**
- **24-pin DIP Emulation Header**
- **Serially links to IBM PC at 115 kBaud**

APPLICATIONS

The main applications of the DS-750 Kit are: -

Evaluation of Philips microcontrollers
Demonstration of microcontroller capabilities
Development of microprocessor based systems
Hardware and software debugging purposes
Training in the field of microprocessors
Programming of Philips microcontrollers

The Ceibo DS-750 supports 87C750 Philips microcontrollers at any frequency allowed by the devices. It is serially linked to a PC/XT/AT or compatible systems and can emulate the microcontrollers using either the built-in clock oscillator or any other clock source connected to the microcontroller.

The clock oscillator generates 40MHz, 20MHz, 16MHz, 10MHz and 5MHz. Emulation is carried out by programming an 87C752 microcontroller with the user software and an embedded monitor program. The DS-750 provides the on-board programming capabilities.

In the real-time mode the user software is executed transparently and without interfering with the microcontroller speed. Breakpoints can be added to stop program execution. In the simulator modes, an additional microprocessor is used to take control of the 87C750 lines and to simulate its operation but not in real-time. This allows access to all the microcontroller functions (I/O, timers, etc.) and interacts with the hardware according to the user software execution or by emulator commands from the host computer. A combination of these two modes allows easy debugging.

The software includes C, PLM and Assembler Source Level Debugger, On-line Assembler and Disassembler, Software Trace, Conditional Breakpoints and many other features.

EXPERIMENTS

Five experiments demonstrate the capabilities and advantages of the 80C51 device and its derivatives.

The DS-750 system is supplied with a User's Manual, debugger and application software (including Cross Assembler), microcontroller documentation (huge databooks!), two samples of the 87C752 and one of the 87C750 (all windowed EPROM microcontrollers), RS-232 and interfacing cables and a power supply.

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Ding dong bell sound generator kit based on a chip-on-board (COB) that 'ding dongs' three times after a pushbutton is pressed. Standby current about 1μA, voltage 1 to 3V, volume higher at higher voltages. Kit includes COB, 4 inch speaker, pushbutton, and a two x AA battery holder. All you need to make a doorbell. **$3.50** ea, or **10 for $3**

UV MONEY DETECTOR
Portable source of UV. New commercial product used to check foreign paper money. Also used in fossicking and gem industries. Has two AA batteries and an inverter to step up the voltage to power a 50mm long, cold cathode UV tube. Simple ringing choke inverter with one transistor, one resistor and a transformer. Inverter can dimly light a 4W fluorescent tube for a source of white light. Takes about 250mA. Case 82 x 46 x 21mm: **$5** ea or **5 for $19**

12V - 2.5W SOLAR PANEL KIT
US amorphous glass solar panels only need terminating and weather proofing. Includes clips and backing glass. Very easy to complete. Size: 305 x 228mm, Voc 18-20V, Isc 250mA. **$22 ea, 4 for $70.**
Efficient switching regulator kit also available: suits 12-24V batteries, 0.1-16A panels, **$27**. Also available, simple shunt regulator kit **$5**

PIR MOVEMENT DETECTOR
Commercial quality 10-15M range PIR movement detectors. Second hand, tested and guaranteed, have relay contact outputs, a tamper switch and operate from 12V DC. Compatible with standard alarm systems. Includes circuit **$10** ea. or **4 for $32.**

DISCO LASER LIGHT SHOW
Our 12V universal inverter kit plus a used 5mW+ helium-neon laser tube head, a used Wang power supplyand an automatic laser light show kit with dichroic mirrors: **$200**

SLA BATTERY BOOSTER
See SC July 96. This 'up' voltage switch mode inverter is designed to charge Sealed Lead Acid batteries and any other 12V lead acid batteries to their end point of 13.8V from 12V car or boat batteries. Also useful for many other applications. Our version includes extra RFI filtering, improved efficiency, and provision to increase the charging current from 2A to 3.5A. Kit includes a silk screened and solder masked PCB and all on-board components, including prewound switching and filter transformers, AND (for free) a 12 hour mechanical timer to interrupt charging (see below). **$25**

STOP THAT DOG BARK
WOOFER STOPPER MK2, as in SC Feb '96. High power ultrasonic sweep generator which can be triggered by a barking dog. Includes solder-masked silk-screened PCB, all on-board components, transformer, electret microphone and transformer! **$39** Single Motorola piezo horn speakers to suit (one is good, but up to four can be used): **$14.** approved 12V DC-IA plugpack to suit: **$14**

SOLID STATE PELTIER DEVICES
12V 4.4A, can be used to make a thermoelectric cooler - heater. Basic info included. **$25** 12V DC fan **$8**

IR REPEATER KIT
Extend the range of existing remote controls up to 15m and/or control equipment in other rooms: **$18**

PLASMA EFFECTS SPECIAL
Ref: EA Jan '94. Produces a fascinating colourful high voltage discharge in a domestic light bulb, or light up an old fluoro tube or any gas filled bulb. The EHT circuit is powered from a 12V to 15V supply and draws a low 0.7A. Output is about 10kV AC peak. PCB and all on-board components (flyback transformer included), and instructions: **$28** (cat K16) Hint: connect the AC output to one of the pins of a non-functional but gassed laser tube, amazing results! The special? We supply a low power functional laser tube for an additional $14, but only if purchased with the plasma kit. Total price: **$42** (Includes instructions on getting the laser tube to produce a laser beam!)

MORE ITEMS & KITS
Poll our **(02) 579 3955** fax to find out how to get our item and kit lists. MANY MORE ITEMS AND KITS THAN THOSE LISTED HERE! *Ask for a list to be sent with your next order.*

FOG MACHINE
Mains operated fog machine: 700W, 3000 cubic meter per minute capacity, remote operation with lead supplied. Great for light shows and lasers! Low introductory price: **$350**

LED FLASHER KIT
3V operated 3-pin IC that flashes 1 or 2 high intensity LEDs. Very bright and efficient. IC, two high intensity LEDs and small PCB: **$1.50** ea, **10 for $12**

SIMPLE MUSIC KIT
3V, 3-pin IC plays a single tune. Two ICs that play different tunes, speaker and small PCB: **$3** or **10 for $25**

MAGNIFIERS - LOUPES
Four types (see review S.C. May 96). Small jewellers eyepiece with plastic lens: **$3**. Others in the range have two glass lenses, used where the loupe is placed close to the object being magnified. Focal point just below base of the loupe. Loupe with 50mm dia viewing area, 10 x mag: **$8**, 75mm: **$12**, 110mm **$15**.

VISIBLE LASER DIODE KIT
We have redesigned our 5mW 660nm visible laser diode kit so the PCB fits neatly into a new hand held case (supplied). Complete pointer kit (with case) at a REDUCED PRICE of **$35.** A similar kit with a 5mW 635nm laser diode: **less than $100**

MINIATURE FM TRANSMITTER
Very small ready-made FM transmitter in a small black metal case. Powered by a 1.5V watch battery (included), has an in-built electret microphone. Tuning range: 88 to 108MHz (adjustable). Range approx 50m: **$32**

RARE EARTH MAGNETS
Very strong!!! Zinc coated. Cylindrical: 7 x 3mm, **$2** (G37) 10 x 3mm: **$4** (G38), toroidal 50mm outer, 35mm inner, 5mm thick: **$9.50** (G39)

VISIBLE LASER DIODE MODULE
Industrial quality 5mW/670nm laser diode module. Dimensions: 12mm dia x 43mm long. Includes visible laser diode, diode housing, APC driver circuit and collimation lens all factory assembled in one small module. Has superior collimating optic, divergence angle less than 1 milliradian: **$65**

FREE CATALOG
Ask for a copy of our FREE catalog with your next order. Many items and kits. Don't forget our website at: http://www.hk.super.net/~diykit

STEPPER MOTOR PACK
Pack of seven stepper motors. Save 50%! Includes 3 x M17, 2 x M18, 2 x M35, all new: **$36**

COMPUTER CONTROLLED STEPPER MOTOR DRIVER KIT
Kit will drive two 4, 5, 6 or 8-wire stepper motors from an IBM computer parallel port. Motors require a separate power supply (not included). Includes detailed manual and software (on 3.5" disk). NEW SOFTWARE will drive up to 4 motors (needs two kits), with linear interpolation across four axes. PCB 153 x 45mm, all on-board components, manual, software and two M18 stepper motors: **$44** This kit with the stepper motor pack above: **$65** Kit, no motors: **$32**

2 CHANNEL UHF KIT BARGAIN
304MHz with 1/2 million codes. Compact transmitter with keychain case, PCB, 12V battery and all components. Receiver kit includes PCB, all components (with 2 decoder ICs and 2 relays with 2A contacts). Range up to 50m. One 2 button Tx kit and one 2 ch Rx kit. Bargain at **$30**

SECURE IR SWITCH
Toggles a relay from an IR transmitter. Coded transmitter and receiver so a number can be used in the same area. Includes commercial one button transmitter, receiver PCB and parts to operate a relay (not supplied): **$22**

MASTHEAD AMPLIFIER SPECIAL
High performance low-noise masthead amplifier covers VHF-FM-UHF and is based on a MAR-6 IC. Includes two PCBs, all on-board components and a balun former. REDUCED PRICE: **$15.**

CYCLE-VEHICLE COMPUTERS
Solar powered, can be adapted to any vehicle. 6 functions, programmable to suit wheel size. Includes mounting kit and Hall effect pick-up. **$32** (G16)

ALCOHOL BREATH TESTER KIT
Has high quality Japanese thick-film alcohol sensor. Kit includes PCB, all components, meter movement: **$30**

CCD CAMERA BONUS SPECIAL
Tiny (38x38x27mm) PCB CCD camera, 0.I lux, IR responsive (works in total dark with IR illumination). Connects to any standard video input or via a modulator to aerial input. SPECIAL pack 1: standard or pinhole camera with bonus VHF modulator OR regulated 10.4V plugpack. **$160**
SPECIAL pack 2: pack 1 PLUS video transmitter (see below): **$175**

VIDEO TRANSMITTER
Low power UHF TV transmitter with adjustable level audio and video inputs, power switch and power in socket. Needs 10 to 14V DC at 10mA. Set to Ch 31, can be altered. Video input accepts standard composite video (eg CCD camera), comes in small metal box and built-in telescopic antenna. Range typically 7 to 10m for internal TV antenna: **$25**

CCD CAMERA - TIME LAPSE VCR RECORDING SYSTEM
Includes PIR movement detector and control kit, plus learning remote control. Combination can trigger any domestic IR remote controlled VCR to start recording when movement is detected, and stop recording a few minutes after movement stops: **$90.**

LOW COST IR ILLUMINATOR KIT
Allows a CCD camera or a night viewer to see in the dark. Adjustable power, 10 to 15V operation at 600mA (max). Has 42 IR 880nm LEDs: **$40**

3-STAGE TUBE CLEARANCE
SC Nov. 95. 25mm 3-stage fibre optic night vision tube, works in starlight EHT supply kit and eyepiece. **$200**

OATLEY ELECTRONICS
PO Box 89, Oatley NSW 2223
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Fax (02) 570 7910 or 579 3955
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READER INFO NO. 25

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Twait (time spent waiting for your scope)

Escape ratio (ratio of signals caught to signals missed)

Sreality (is my scope displaying the real signal?)

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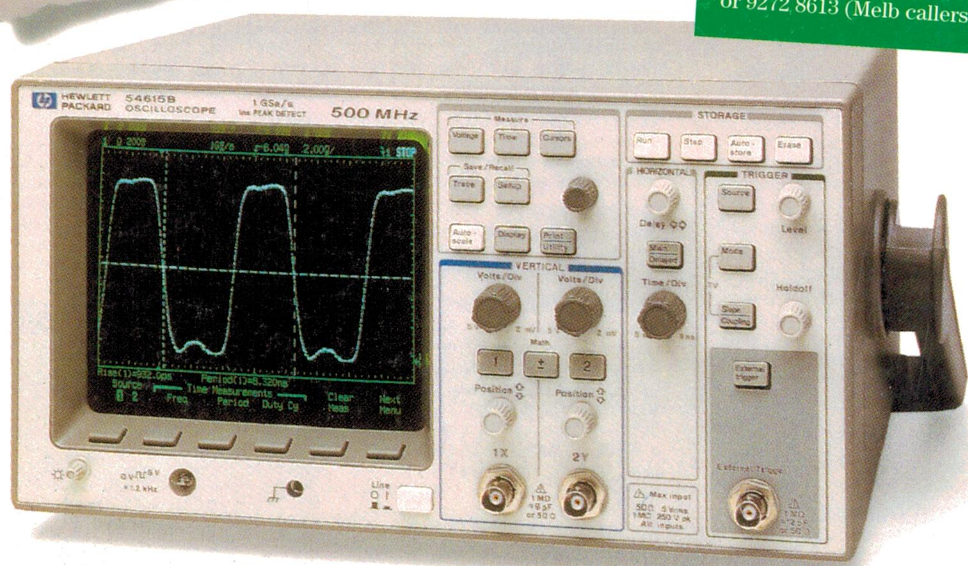

HP 54615B	HP 54616B
1 GSa/s sampling rate	2 GSa/s sampling rate
250 MHz single shot bandwidth	500 MHz single shot bandwidth
500 MHz bandwidth	
1 ns peak detect	

All scopes look wonderful on paper.

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